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B. BURGESS, Captain,
Secretary.

Whitehall Yard.

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Friday, January 9, 1891.

ADMIRAL SIR W. HOUSTON STEWART, G.C.B., Member of Council, in the Chair.

A PROPOSED METHOD OF TRAINING NAVAL STOKERS, AND OTHERWISE INCREASING THE EFFICIENCY OF THE STEAM BRANCH PERSONNEL.

By Chief Engineer J. LANGMAID, Royal Navy.

IN bringing this subject before the notice of the members of the Royal United Service Institution, I have been greatly influenced by the speech of the First Lord of the Admiralty at the Royal Academy Banquet on 3rd May last, when he said: "It is necessary for us to endeavour to establish in the Royal Navy such a system of training and education as will give both Officers and men adequate knowledge of the duties they are called upon to perform." My object in preparing this paper is to show how this can be made to apply to the steam branch personnel of the Royal Navy; more especially to the stokers.

The training of the military branches of the Royal Navy, including Officers, warrant officers, seamen-gunners, torpedo-men, seamen, marines, and marine artillerymen, with coastguard and other reserves, appears to be most complete; and everything is done that experience can suggest. The result is that, from a purely military point of view, our Navy is in a very satisfactory condition. With stokers the case is altogether different. Our ships are commissioned and sent to sea with a large proportion of the stoker complements totally untrained in their duties; the consequence is that for months after a ship is commissioned she is not in a fit condition to meet an enemy.

We find evidence through the whole of the reports of our Naval

Manœuvres of the value of speed. In real warfare it is quite possible that a knot or so in speed might make all the difference in capturing or being captured; and it is just that last knot we should be unable to get under present conditions. To quote from a speech made by Captain Noble, of Lord Armstrong's firm, at a meeting of the British Association last year, "In future naval battles, the *weather gauge* will belong to the fastest vessel and the best engineer," meaning, of course, by "engineer," the best engine-room complement.

I propose to show in this paper, firstly, that a great change is necessary before the stoker complements of our battle-ships and cruizers for months after commissioning can be considered efficient; secondly, how this change might be effected; and also, to suggest other ideas for increasing the efficiency of the steam branch personnel.

If we refer to the Report of the Naval Manœuvres of 1888, we find the opinions of several of the Captains in command of ships employed given to show that these ships were deficient in their supply of trained stokers; also that, in point of physique, the men employed were "unequal to their work, and in many cases their experience in stokehold or any other work on board ship was *nil*."

From Admiral Baird's report on the proceedings of the fleet under his command during the 1889 manœuvres I quote the following extracts:—

"I cannot urge too strongly upon their Lordships' consideration the inadequacy of the engine-room complements of modern ships and cruizers; not only does this apply to the number of ratings authorized, but to the fact that so large a proportion of the crews comprise stokers, 2nd class, and a large number of the stokers are men who have been advanced to that rating for drafting purposes while still untrained."

"I had been led to believe that there was a proper standard as regards height and chest measurement for stokers; but, judging by their physique generally, it would appear that such is not the case. The men are willing enough, and do their best, but are quite incapable of undergoing the labour required, nor, in fact, can it be exacted of them, since they become exhausted and faint."

"Captains, without exception, have spoken to me on this subject; and represented it as actual cruelty putting these men to work at the fires, as they have been forced to do when chasing or being chased."

"This is a grave matter, and demands immediate action, as in wartime it will not be practicable to supplement the stokers with deck hands, especially in modern ships, with complements cut down to the lowest possible scale; nor, when sent down, are they of any use but to trim coal, and relieve the firemen of that laborious work."

In newspaper reports of the commissioned trials of the "Trafalgar," "Mercury," and "Magicienne" at Portsmouth last year, these ships were said to have obtained "a high rate of speed on the measured mile, equal, in fact, to what was obtained on their contractors' natural draught trials." This appears to a certain extent satisfactory; it shows that their machinery had been kept in an efficient state, and

also that the power and speed could be obtained under favourable circumstances.

It should not be forgotten, however, that these results were obtained with good stokers sent for the purpose of the trials, according to Steam Reserve Instructions; and that, as far as the efficiency of these ships was concerned, independently of outside help, the reports were misleading.

The stoker complements of these ships, also of others commissioned for manœuvres in 1890, were made up of—one-third experienced men, one-third men who had just been rated stokers, and one-third of stokers, 2nd class, fresh from the shore. When it is considered that a large proportion of the experienced stokers must be employed outside the stokehold in looking after the main and auxiliary engines, &c., it is evident that very few experienced men were left to do actual stokers' work.

I have not yet seen the Official Report on the Manœuvres of 1890, but it is generally known that, owing to the large number of untrained stokers employed in the ships engaged, the amount of work thrown on the trained men was very great, as was also the anxiety caused to the Engineer Officers.

The number of stokers now required for manning the Navy is 9,300, so that, allowing say 30 per cent. for losses of various kinds, and that each man of the remainder serves twenty-two years, about 600 men must be recruited annually, and if no change is made, sent to sea with no training in engine-room duties.

In modern ships of the cruizer type, the stoker complement is almost as numerous as that of bluejackets; and the majority of these men, even supposing they are good stokers, have no training whatever in boating and other necessaries of a sea-going life.

I know that for some years past attempts have been made to train 2nd class stokers in troop-ships; but a small percentage only of the men can be trained in this way, and the training is not of the best kind. My experience of this kind of training was that, whenever there was any difficulty in getting or keeping steam, the 2nd class stokers were at once taken off the fires, and the good firemen put on; so that at the very time the 2nd class men might have gained some useful experience, they had to be put to trimming coal.

During the last two or three years 2nd class stokers have been put through a course of company and small-arm, &c., drill on joining the Service. This is, undoubtedly, of great advantage to men who have to serve in fighting ships, and teaches them habits of discipline, but does not prepare them for their principal duties.

It appears, therefore, to be very desirable that, before men are embarked for active service, they should undergo a considerable period of training both in stokers' duties and sea-going work generally; and I now suggest a method for carrying this out economically and efficiently.

I propose that all newly entered men should be sent to a central training ship, in the same way that Royal Marine recruits are sent to the depôt at Walmer, and be trained there for three months; this

course to be followed by three months' sea experience in a modern cruizer. At the end of the six months they might, if qualified, be rated stokers, and sent to sea-going ships.

Supposing 600 men have to be trained annually, 150 men would have to be accommodated in the harbour ship and 150 in the cruizer.

The "Marlborough," tender to H.M.S. "Asia" at Portsmouth, would suit admirably for the harbour training ship, having ample messing accommodation, and being already fitted with cooking, warming, and other appliances, space in hold for a gymnasium, &c. For a comparatively small cost, she could be fitted with lecture and instruction rooms on upper deck, similarly to "Vernon," "Defiance," &c. Little or no extra expense would be necessary for supervision, victualling, medical, and other arrangements. Men joining the various Reserves between the courses of instruction might be instructed in drill, &c., which would not interfere with the work of the regular classes.

The course of instruction should include :—

1. *Names and Uses of Principal Parts of Boilers and Engines.*—This could be readily taught in classes by means of suitable models and drawings; so that when the men saw the actual things they would recognize them, and remember what they had been told about them. If properly taught the uses of things, they would afterwards do their work, such as cleaning a boiler for instance, much more intelligently and interestedly.

Besides this they could be taught the names and uses of the various fire-irons and tools commonly used in stokeholds, to read a pressure-gauge, to understand the telegraph and to use the voice-pipe, to trim and fill a lamp or a lubricator, to close a stop-valve, which even a newly joined man might have to do on an emergency, and many other of the usual stokehold duties. As things are at present, a young stoker is hardly fit to carry a message even for the first few months of his service at sea.

It might be found possible and advantageous to teach the more intelligent men some of the first principles of the steam-engine, the use of a vacuum, the action of a pump, &c. Some of these men must become leading stokers, and be employed on detached duty in steam-boats; and would certainly do their work better with an intelligent knowledge of it.

It may, perhaps, be argued that this is going rather too far: but, considering the advance in education during the last few years, and that men do acquire knowledge at present, and often show themselves really intelligent, I consider that an early opportunity of developing this intelligence would be advantageous to the men themselves and to the Service.

2. *Duties of a Stoker in Managing Fires.*—Before a man can manage a fire he must be able to use a shovel; this takes considerable time to learn in the ordinary way, and causes loss of coal.

It is no easy matter to keep a furnace properly supplied with coal. A man has to learn to see through the flames where coal is wanted, and then put it there. The bare difficulty of simply supplying a

furnace 7 feet long and 3½ feet wide, through an opening 14 inches by 9 inches, level with a man's chest, can be imagined. I need hardly say the difficulty is increased if the ship happens to be rolling. I am sure that any one who has seen a stoker using a shovel for the first few times will agree with me that he should be taught this before he goes into a stokehold.

This work might be taught in an instruction room, by fitting up a few dummy furnaces, including "high" and "low" ones. A man could then learn under convenient conditions how to put coals on the furnace bars wherever required; so that when he went to the sea-going ship he would know the rudiments of his work, and would learn the other part much more readily. Coals need not be used for this purpose, a cart-load of macadam stones would serve instead and prevent waste.

3. *Knotting and Splicing.*—Whatever stokers learn of these useful accomplishments is what they can "pick up." So that although some know a little about it, the majority know nothing. I have often found that the most useful man in the engine-room, when weights had to be lifted during repairs, &c., was a bluejacket who had changed his rating.

The Engineer Officer of one of our largest ships has recently told me that last year, when overhauling his machinery, and working day and night, he had himself to sling all the weights, put luffs on the tackles, and all that sort of thing. Although he had a staff of fifty-six men, not one of them had any knowledge of this kind of work.

I consider a stoker, to be of real use, should know the ordinary knots and splices, bends and hitches, be able to reeve a tackle, sling and lift any ordinary piece of work, make and sew a gasket, all work of the kind in fact, likely to be necessary.

4. *Boat Exercise, Rowing, &c.*—Now that so large a proportion of our ships' companies consists of stokers, this knowledge appears to be absolutely essential. For instance, the "Blake" and "Blenheim" have each 142 men holding stoker ratings, and it appears at least expedient that this large body of men should have had some instruction in boat work. After being some years in the Service they may know a little about it, but would always be clumsy unless properly taught. Swimming also might be taught during the summer months.

5. *Drill, Rifle and Cutlass Exercise, &c.*—Stokers are already taught this, and are certainly all the better fitted by the knowledge to form part of the crew of a ship of war. For boat expeditions, or for prize crews in war time, in which stokers must form a large proportion, these men would be better fitted for their duty if fighting men as well.

6. *Gymnastics.*—There is already space in the hold of the "Marlborough" which has been used as a gymnasium; this might be again fitted up, and instruction given to stokers as to Army recruits. By this means the physical development of the men would be greatly assisted, and they would be able to use afterwards the gymnastic fittings supplied to H.M.'s ships.

Although mechanical appliances are now greatly used, yet physical strength in a stoker is as much required as ever.

7. *Miscellaneous Duties of Stokers.*—A good, handy stoker must be a regular "Jack of all trades." He has to mix and use paint and yellow wash, mix cement and mortar, lay fire-bricks properly in rebuilding furnace bridges, strike for the blacksmith, and a host of other duties, which would be more efficiently performed if properly taught.

There are several precautions to be taken before a man enters a coal bunker or a double bottom, for the prevention of fire, &c. A man would work much more intelligently if these were properly explained, or at least pointed out to him before he went to sea.

It might be possible to teach the men some elementary ambulance work, &c., which would probably be afterwards found useful. At a meeting held here last June, several Army Surgeons were of opinion that every soldier should learn ambulance work. I think this also applies to stokers, who are particularly exposed to the dangers of burns and scalds.

School work might also be done if time allowed.

This course of instruction might be arranged, approved by the Captain of the Steam Reserve for nautical subjects, and by the Chief Inspector of Machinery for technical subjects, and submitted for the approval of the Admiralty.

The teaching staff need not be large, one senior and one junior Engineer Officer, with about three or four good chief or leading stokers, would probably be sufficient for the technical subjects, with one of the warrant officers at present employed for drill instruction, and a few seamen petty officers, as in boys' training ships, for the nautical subjects.

I would not propose to alter the present arrangements for instruction in use of torpedo-boat machinery at the various ports, as these are used for instruction and practice of more experienced men.

The three months' course of instruction in the harbour training ship should be followed by another three months' instruction in a sea-going ship.

In a letter to the "Times," dated 11th October, 1888, Lord Brassey made this suggestion in the following words:—

"In the manning of the Navy, the blot which it is most urgently necessary to remove is the defective training of the stokehold and engine-room staff. The mobilization puts numbers of young untrained artificers and stokers into the ships, and difficulties must be expected. We are making progress in the management of the machinery of torpedo-boats. We are training men to this work by keeping a few boats manned from the torpedo schools constantly under way. A vessel of the 'Archer' class, and another of the 'Severn' class, should be kept in commission at the home ports. All young Engineers, artificers, and firemen should go through a course of instruction in these vessels in the management of engines at full speed. At Spezzia, an ironclad of the Italian Navy is daily under way for a similar purpose."

With this I think most people will agree. One of the larger vessels

of the "Apollo" class would now be more suitable, and I would propose to attach one of them to the harbour training ship, to be always in commission, with a small permanent staff of Officers and men, and used for the practical seagoing instruction and training of Assistant Engineers, engine-room artificers, and stokers.

In the Report of Admirals Sir W. Dowell, Sir R. V. Hamilton, and Sir F. Richards, on the Naval Manœuvres of 1888, the following paragraph occurs:—

"We would call attention to the fact of the large number of deck hands employed in the stokeholds of many of the ships engaged in the late manœuvres, which would point to a deficiency, either in the complement, the quality of the stoker, or to inexperience; and from what came under our own personal observation as Commanders-in-Chief on foreign stations, when ships were recommissioned abroad, we are inclined to attribute it to inexperience, as there was no doubt as to the great improvement in the stoking after a few months' practice."

There appears to be every reason why these few months' training should be acquired in the proposed manner, instead of in a vessel on active service. During the three months the men were embarked in the cruizer, they would probably get as much actual full power running as in a year or more of a commission in an ordinary seagoing ship.

There are twenty-nine second-class cruizers of the class before mentioned to be added to the Fleet under the Naval Defence Act; these ships have their propelling and auxiliary machinery of the latest types, and of the same description as that fitted to the first-class cruizers and battleships.

The whole of these ships would probably be commissioned in wartime, and it would be a very decided gain to their early efficiency if their engine-room complements, or the greater part of them, had already served in a ship almost identical in her fittings. This is an important point when we consider that a modern war would probably be settled in a very short time; and that it would be our aim to keep the command of the sea from the commencement.

Supposing the 150 men were put on board for three months' training, the first fortnight might be spent in harbour, during which time instruction might be given in the uses of the various parts of the boilers and machinery, the working of auxiliary engines, &c. The ship might then be taken to sea at the beginning of each week, and kept going for about four days, beginning at slow speed, and gradually working up faster as the men got used to their work. Towards the end of the three months they would probably be able to work up to something near the natural draught full power.

On the completion of each four days, the ship could return to harbour, coal, clean up, make good necessary adjustments or defects, give leave, &c. In summer time, Portsmouth might be the headquarters; in winter Malta, or some other Mediterranean port, away from fogs, &c.

For steaming, the men under instruction could be arranged in

four watches; this would allow enough men below, and the work would not be irksome. They might possibly keep up their knowledge of drill during their long spell off watch.

At the commencement of each week the men's stations might be changed, so that during the three months' training each man would have several turns at trimming coals, firing, and looking after main and auxiliary engines, &c. He would also have taken part in coaling and trimming in bunkers, sweeping tubes, cleaning the various parts of the machinery and boilers, and assisting in making good defects. He would have got accustomed to the sea, and become in every way more suited to his work.

At the end of the six months' training, the 2nd class men, if found qualified, might be rated stokers; if unqualified, but likely to do better, they might have three months' more training; if hopeless, they might be discharged to the shore, certainly none the worse for their six months' experience.

The only difficulty in carrying out the sea-going training in a ship of the "Apollo" class would be the necessity of finding adequate messing, sleeping, and washing accommodation for the men under instruction. But a few slight temporary alterations or modifications would get over this.

The ship being used principally as a training school for stokers, some of the guns might be left in store in the dockyard, also the broadside torpedo tubes and carriages, and most of the torpedoes. The deck complement might then be reduced to allow only sufficient men to work the ship: a specially arranged temporary complement, say on the scale of the smaller troop- and store-ships would probably be sufficient.

There is sleeping accommodation in these ships for about 270 men, so that allowing for 150 men under training, there would be accommodation for a permanent crew of about 120.

The ordinary stokers' wash place would not be large enough for so many men, but the port upper coal bunker might be used temporarily; the necessary fittings could readily be put up, and taken down again if the ship were required for active service at any time.

I have heard it suggested that seamen might be taught stokers' work, and so might be interchangeable, either for deck duty or below. I do not consider this plan would work; there is quite enough for the average man to learn to do properly in either position; and what we want particularly to aim at is, that the men employed below should be really good and efficient stokers, whether employed as firemen, oilers, auxiliary engine-men, in torpedo-boats, or on any other mechanical duty.

Having dealt with the training of stokers, I now pass on to the second part of the subject, viz.: "Otherwise increasing the efficiency of the steam branch personnel."

The proposed cruizer would be a very useful school of instruction for junior Engineer Officers afloat before going to sea-going ships.

The system of training Engineer Students at Devonport is so good that few suggestions as to its improvement during their course there

could be made. The Students attend steam trials of ships, but necessarily in an irresponsible capacity; and they would be undoubtedly benefited by a course of instruction after joining the Service such as could be given by this method.

For the sea-going instruction of Officers who obtain direct commissions as Probationary Assistant-Engineers from private engineering firms and colleges, a course of training such as could be afforded by this means appears most necessary.

Besides being instructed in engine-room duties, these young Officers might be taught to keep an engine-room register, Engineers' store accounts, to arrange watch and station bills, and much of the other technical clerical work which has to be learnt at sea.

It has been recommended by a great authority on naval matters that these young Officers should be sent for a few trips in one of the fast Atlantic mail steamers to gain experience. I am of opinion that the method of training in a cruizer would be preferable.

The conditions are so different in the two Services that little useful experience would be gained by the former method. It might, perhaps, be advantageous to send a few senior Engineer Officers for a voyage or two, as they would know what to observe, and notice any points worthy of adoption.

I have taken several opportunities while at Liverpool of noticing the harbour routine of these ships for examination of machinery, &c., and have admired the almost mechanical regularity with which everything is undertaken, but here again the conditions are altogether different from those of our Service.

They have long acquaintance with one particular class of engine, specially designed for continuous high speed; short and definite passages; a certain fixed time for examination and repair; every man drilled to one particular duty; plenty of room for everything; convenient lifting appliances; a cool climate; good shore factories with no question of estimates, and efficiency the first consideration.

The whole system of carrying on work is so different to ours that no comparison can be made; but possibly senior Engineer Officers might get useful hints in these ships in harbour as well as at sea.

With respect to the training of engine-room artificers, they would be undoubtedly more efficient when sent to sea-going ships if they had passed through a course of instruction in a modern cruizer as suggested.

These petty officers are of various trades, engine-fitters, boiler-makers, engine-smiths, and copper-smiths: the engine-fitters are naturally most suited for engine-room work; but as they come largely from locomotive and agricultural engine works, it is evident that they have a good deal to learn on joining H.M.'s Service before they become conversant with the marine engine; while men of the other trades are at a still greater disadvantage.

Knowing this, it appears difficult to understand how we manage to get on as well as we do without some system of teaching the men their duties. Of course they learn after a while, but in the mean-

time someone else has to do their work, and their ship cannot be considered efficient.

Another point with respect to these men is that they have, while untrained, to be put nominally in charge of a watch, but the best man in the watch for some time is the leading stoker. Now if the engine-room artificer could be trained to his watch-keeping duties before going to a sea-going ship, he would not be placed in this false position.

While considering the training of junior Engineer Officers, I think it would add to their more efficient and thorough knowledge of their duties, and also to that of senior Officers, if some effort could be made to keep them officially posted in recent inventions and improvements in steam and other machinery affecting the Royal Navy.

There is no Intelligence Department for the Steam Branch of the Navy; possibly we have not much to learn in the mechanical way from foreign nations; but I consider it would be beneficial if we had an "Annual Report" of the Engineer Department, similar to that of the Gunnery and Torpedo Schools. This Report to include sketches and descriptions of new inventions in machinery and appliances fitted to H.M.'s ships; speed and consumption curves of new classes of ships, so that Engineer Officers of similar ships would have some guidance as to what might be expected of their own ships; reports of defects which become apparent in new ships, and how dealt with; by this means Officers in similarly fitted ships would know what to guard against, and take precautions accordingly. Reports of trials of new ships and of ships in commission might be included, also notes on coal found on foreign stations and used in H.M.'s Service; notes on the use of steam jackets, and other useful information might be given. Much of this information is now sent home in the reports in engine-room registers, but is known only to a few.

For example, if we take the case of the twenty-nine second-class cruizers shortly to be added to the Fleet; supposing the particulars as indicated above for the first one or two commissioned were given to the Engineer Officers of the remainder; much time would be saved, and the country spared the expense which would be incurred if each had to undertake speed and consumption trials, &c.

At present most Engineer Officers have only their own personal experience for guidance, or what they can gather from the professional journals and newspaper reports, accurate information of the kind suggested being often difficult or impossible to obtain. The information given in these reports might form one of the subjects for examination of junior Officers passing for higher ranks, and these Officers might thereby be stimulated to keep themselves posted in all information affecting the department.

To return to the subject of stokers: the men who at present join the Royal Navy as such are, to judge from reports previously quoted, and from what we can see daily in our dockyards, very inferior in physique. Now I have read in the Service papers that the 1,100 men recently required to increase the corps of Royal Marines were rapidly raised without lowering the standard of height, &c. I saw in the "Army and Navy Gazette" of 24th May last, that the average height

of men leaving the depôt to join headquarters was, artillery 5 feet $9\frac{1}{2}$ inches, infantry 5 feet $7\frac{3}{16}$ inches. So that one thing appears evident, viz., that the Royal Marine Corps is popular and can be readily expanded, while it is very difficult to get stokers. Possibly the money paid for recruiting Marines influences the supply.

Of course, from the nature of things, a stoker's life and duties are to a large extent disagreeable, but there are various ways in which his lot could be improved, and in course of time the life become more popular.

I consider the course of training suggested would assist considerably. A promising man would be much more likely to join the Service if he knew that he would be at once taken in hand and trained, so that in about six months' time he would be getting stoker's pay, than if he knew he would have to remain a 2nd class stoker an indefinite time as at present.

This course of training would also fit stokers to join the Coastguard. I am informed that at present there are only about 200 stokers in that Reserve, and very few, indeed, in the Royal Naval Reserve. If the number of stokers in the Coastguard were raised, it would be an inducement to men to join the Navy, and be an evident advantage to the Service.

It is probably worth consideration whether a 2nd class petty officer rating for stokers might be instituted. There are now chief and 1st class petty officer stokers, but no 2nd class. It often bears hard on good men, that although qualified in every way to serve as leading stokers, there is no opportunity to rate them; so that they have to serve on the same pay and with the same privileges as inferior men for considerable periods.

I would suggest that a 2nd class rate be established, to include stoker mechanics after three years' service, and other good and trustworthy men who have qualified as "trained men" in small arms, managing torpedo-boats' boilers, and have a good knowledge of engine-room and stokehold work. Their pay to be, say, 3*d.* per day more than stokers', and to be called "stoker mechanic" or "stoker, 1st class." This would be a great assistance to Officers in being able to reward suitable men, and would give a man something to show his qualifications.

There are other points worth consideration. It would probably be worth the outlay, if the 2*d.* per day on re-engaging for a second term of service were given to the stoker as to the bluejacket; and if a progressive rate of pay were given to chief and leading stokers, especially on their rejoining for an additional five years' service. An additional meal, consisting of a ration of cocoa and biscuit, might also be issued to stokers during the middle and morning watches. From tea time to breakfast is a long time, and under steam stokers have to do six hours' work before these meals.

I think there is no doubt that if these suggestions were carried out, the men would be more contented with their lot, and there is also no doubt but that the men, if contented, would form the best kind of recruiting agents.

Of course these suggestions, if carried out, would cost money. I

have made a rough estimate of the probable cost of maintaining the harbour and sea-going training ships, and do not think it would exceed 20*l.* per man trained. This is only a small fraction of the cost of training a seaman, and I think would be money well spent. We shall soon have an efficient fleet of ships, and it would be a good thing to have efficient men to put into them.

I may add that I have consulted on this subject with many senior Engineer Officers, including several of those who served in ships during the last and previous manœuvres; and that they entirely agree with the suggestions in this paper.

In conclusion, I cannot do better than quote from the concluding part of Lord George Hamilton's speech, already referred to:—

"Whenever that untoward event (war) occurs, I think it is pretty plain that the victory will rest not with numbers, but rather with those who, by their instincts, their training, and their skill, have the most complete control and manipulation of the deadly instruments of destruction which science has placed at their disposal." And I believe that the system of training suggested would add very materially to our chances of success, as its neglect certainly tends in the opposite direction.

Chief Engineer EDWARDS, R.N.: I must say, taking the paper altogether, that I entirely concur in the remarks that Mr. Langmaid has made on the subject of training stokers. This is the first time that I remember the question having been discussed in this Institution, and I think it has not been dealt with a moment too soon. It is somewhat remarkable that, although we hear a lot about stokers being trained in work outside the engine-room, we never hear that steps are to be taken to train them in their proper duties. It is only this morning, for instance, that we read in the "Times" that orders have been issued to the Steam Reserve at Portsmouth that stokers are to be trained in the use of small arms. I am very glad to see it, but one never hears of any instructions being issued about their being trained in their own work. I think this is a most important point. I have talked over this subject with many engineer Officers who have taken part in the Naval Manœuvres, and they all concur as to the inexperience of the great majority of the engine-room staff, and, secondly, as to the want of physique of newly-joined stokers. Of course the two points almost go together, because, naturally, as we have been so short of stokers lately, we have had to draft men on board the ships who have had no training whatever, and who have been almost raw youths. I think it is quite time that we instituted some system of enlisting stokers that would enter them at an earlier age than is done at present. The men want feeding up before they are fit for their work. As a rule, we put off engaging men until we actually want them at sea, and then we have to pick up anyone who comes along. I am quite of opinion that if we had two or three training ships, and stokers were entered at the age of 18, and trained for one or two years to their laborious duties, the Service would be all the better for it. For the training of seamen we have no less than four or five training ships. We have a fleet of training brigs, a training squadron, the "Excellent" and the "Vernon," all maintained to teach seamen their special duties; all this is, doubtless, very necessary, but I must say in these days, when stokers play so important a part in the work of the ship in keeping her going, a system of training for them is quite as necessary as a system of training for seamen or gunners. Of course, in the old days, the men who were taught to fight the ship were the men who also had something to do with her propulsion. Now we have got rid of masts and sails practically in the Navy; at all events, I take it a system of training men in the use of sails has almost become obsolete; but in its place a necessity has arisen for training men in duties connected with the new method of propulsion. The old sailors could repair the

sails and the rigging, and do all the work that was necessary on deck which had to do with the propulsion of the ship. We have no system of that kind whatever with the bulk of our engine-room staff, and if the men pick up anything at all below, they do it in a very haphazard way. I think if we had some ship in a dockyard where stokers could be taught rifle and cutlass drill, gymnastics, and also the rudiments of engineering work—ordinary repairs in the engine-room, something of the nature of the tools they have to deal with—to read a gauge, to screw a nut down, to make a joint, and to know the materials employed in making joints, it would be a great advantage. In fact they should know all the ordinary duties for which we do not require the services of skilled mechanics. With regard to making stokers and seamen interchangeable, I think, taking in view the changes that have taken place in ships' complements in the Navy, it is quite time we did consider some system of making all men fighting-men in the ship. In torpedo-boats, torpedo-catchers, and vessels of the fast-cruizer type, the stokers form a very large percentage of the crew and are practically non-combatants, which is a very great evil, especially where you can only accommodate a small crew. Of course the anxiety of the engineer Officer is to see first of all that the stokers should be trained in their proper work, but from the point of view of the naval Officer generally, they should also be trained in fighting duties, so that the fighting efficiency of the ship should not be impaired by the necessary increase in complements which has recently taken place in non-combatant stokers. I think the training of stokers in cutlass drill does not go far enough. I would put stokers through a course of every kind of drill that the bluejacket gets; but to do that you would have to make the lower ratings or classes interchangeable; there should be, say, three watches below and two or three on deck, and they could be kept circulating between the engine-room, the stokehold, and the deck. Men, as soon as they are made petty officers, should be retained in their particular department. A man who had been trained both as a stoker and a gunner might be promoted to any particular post for which, in his all-round training, he had shown special aptitude; if he is a better gunner than a stoker, then he can be made captain of a gun; if he has been a better stoker than gunner, he would be better kept to fill the rating of a leading stoker. There is one point I should like to mention with regard to the training of the artificers. The men who have been lately recruited to fill these ratings are, in many cases, taken from the large manufacturing districts. The men in those districts are trained to do one particular kind of work; the division of labour in these districts is so minute, and workmen are employed so much on piece-work of one particular kind, that a man is not a good general all-round man, and these men are practically useless on board ship for a year or so. I am perfectly convinced of the necessity of instituting some system of training engineer artificers. I see no reason why they should not be trained in a dockyard. I am quite sure you would get a much better class of men as far as the requirements of the Navy are concerned. They would get just the kind of instruction in naval machinery that you want; they would get familiar with ships, gun machinery, torpedo machinery, and so on; and they are more suited for the work of the Navy than the men we get from the Tyne and from the Midland counties. The system, I think, of training stokers at present is very irregular and meagre. We send in the troopers 15 second-class stokers on each trip for training. I think the complement of the Indian troop-ships include 30 first-class, 15 second-class, and an additional 15 second-class stokers for training, and these latter 15 are changed every trip. I was talking the other day to an engineer Officer of an Indian troop-ship, and he told me that nearly the whole of the second-class stokers invariably had to knock off work when going through the Red Sea; they had every inducement to keep to work in the shape of tropical pay, but they could not stand the fatigue; with every desire to go below and do their work, it was too much for them; they were not strong enough. That point alone, I think, emphasizes the necessity of training and feeding our own men before we put them to sea at all. If they had spent some time in a ship alongside a dockyard and were fed up well, I am quite sure they would be able to do the work better when they get to sea in a commissioned ship, and would be of much more assistance to the engineer Officers of the ship. There is

one thing with regard to the training in combatant duties; it makes them discontented; they say if they are made to perform the work of bluejackets they do not see why they should not be treated as well as the bluejackets. Mr. Langmaid suggests that the stokers should be given the 2*d.* a day on re-engaging. They are not given that now, but the bluejackets have it. I asked a leading stoker the other day why so many of his men did not re-engage at the end of ten years, and he said, "I do not see that they can expect us to; we only get 2*s.* 5*d.* a day, and now we are drilled as soldiers in rifle and cutlass drill we think we are worth as much as the petty officer bluejackets." I think myself the point of giving the men the 2*d.* a day is worth considering, because it stands to reason that a man who has had ten years' training in the engine-room is worth retaining in the Service. I do not think that 2*s.* 5*d.* a day is enough pay for them. In the leading mercantile lines the principal stokers get 6*l.* 10*s.* a month, and the coal trimmer gets 4*l.* a month. Our *leading* stokers, with everything in the shape of extra pay for badges, "trained man," &c., can only get 3*s.* 1*d.* a day, or 4*l.* 11*s.* a month, and these men if they were taken on the Atlantic liners would get much more. Of course they get a pension. The introduction of the second-class petty officer rate would also meet a great want of the Service. I was in a gunboat some time ago which only had two petty officers as stokers. There were three or four men that I would have liked to have promoted if I could, but I had no chance of rewarding them, and they had to remain stokers the whole time. It often happens in a gunboat we are shorthanded. In one case, two of the engine-room artificers were invalided, or in the sick list, and we had to put a leading stoker and a stoker to look after the watch, so that we had an engine-room artificer, a leading stoker, and a stoker each in charge of their respective watches; of course that could not be done in a big vessel. There is another point that strikes me, that is, that under the present system in a large ship we have practically to take the cream of our men from the engine-room and to scatter them all over the ship, looking after the auxiliary engines, *i.e.*, the hydraulic engines, the electric lighting engines, the capstan engines, &c.; we have to take our best men, whom we can trust by themselves, to do this work, and practically we have nothing but the untrained men left below in the early part of a ship's commission to do the real work of the engine-room. That evil would be modified, if not prevented, by training stokers in stoking duties before they went to sea at all. I do not see myself why we should not have one or two training ships kept constantly at sea for stokers; it would certainly pay us even in the amount of coal that the better stoking would save in a year or two; the saving in the coal would make up for the cost of training our men. Of course, in proposing any new scheme initial expense is certain, but the future economy is problematical. That objection is often heard, but I am quite sure in this case the future saving is quite as certain as the initial expense, and I think it behoves us all to try and see if we cannot institute some plan of giving our stokers some definite system of training better than the present.

Chief Engineer C. E. STEWART, R.N.: Whilst agreeing generally with Mr. Langmaid's paper, I would like to say a few words as to his proposed system of instruction for stokers more especially. My view of the case is that our first and greatest idea is to make a man an efficient stoker, and with that view I would reduce the time for instruction in the proposed depôt from three months to one month at the most. I consider that we educate him sufficiently there by teaching him the names of the principal parts of the machinery only, teaching him to use the shovel more especially, and giving him a very general and rough idea of the duties in the stokehold of a ship-of-war at sea. I think if he were then sent to sea in a cruizer for a period of five months or less he might be trusted, being a man of average intelligence, to gather all that was required of him in the engine-room, and I think the method I propose would tend to make a more efficient stoker of him as a stoker, or I should say as a fireman. That, I think, is the great desideratum, because speed in these days is everything in a ship-of-war, and we can only get speed out of our ships by having efficient firemen. All that Mr. Edwards has so well said as to the matter of economy attained by efficient stoking is undoubtedly true, but economy becomes insignificant in war-time; the last half knot is the great thing required, and if we had good stokers and firemen, irrespective of the duties in the engine-

room, I maintain that we are likely to get that half knot, and not otherwise. The special duties in the engine-room, I think, the men can learn from the artificers. An artificer, himself an experienced mechanic, though possibly he is not familiar with the machinery of a war-ship, is still familiar with machinery of some type, and he very rapidly becomes expert in war-ship machinery, and the man who works with him learns all that is required in that way. Beyond that, I think I am fully agreed with Mr. Langmaid in every word that he has said in his paper.

Admiral CLEVELAND: In the first place, I wish to congratulate Mr. Langmaid upon coming here to give us information upon a very important subject, and I should like to see more of his brother Officers telling us, on the floor of this theatre, what they think should be done for the credit and efficiency of their department. It is far better that it should be done through the agency of this Institution than through newspapers or periodicals. I am in entire accord with all that Mr. Langmaid proposes, but his plan would require to be supplemented by a scheme propounded last year by Mr. Williams, Inspector of Machinery in Devonport Steam Reserve, who, in addition to what Mr. Langmaid proposes, would increase the complements of our men-of-war by a large number of stokers, increasing the establishment, so as to permit of one-third or a quarter of the engine-room staff being relegated to deck duties—pulling in boats and small-arm drills—for a month or so at a time. I certainly think that entering stokers at a central depôt in the first instance is a thing that is very much needed in the Service, and there training them, as he says, for about six months (three months at preliminary drill and three months at practice), would tend to uniformity and efficiency; they would be on probation during this period; and, apart from learning the *raison d'être* of their work in the stokehold and engine-room, boat exercise, machine-gun drill, rifle and cutlass exercise would be taught better than what is done at present in our Steam Reserve ships. It seems to me to be a very much better system, and they would be drafted to the Reserve ships as capable stokers. There is a statement in the lecture which I would rather Mr. Langmaid had omitted: he says, "From a purely military point of view our Navy is in a very satisfactory condition. With stokers the case is altogether different." The implication is that there is a marked distinction between these branches of the Service. I would ask Mr. Langmaid to dismiss that idea altogether from his mind. W are, or should be, all united together for one great work, that is, to develop the resources of our ships to the utmost extent. There is no difference between the engineer branch and the military branch; one is as necessary as the other to the efficiency of a man-of-war; otherwise I may say I concur in every part of the paper, and I will conclude by congratulating Mr. Langmaid on having dealt with a difficult subject with such great care and efficiency. He believes that the system of training suggested would add very materially to our chances of success, and that its neglect certainly tends in the opposite direction. I entirely endorse that view.

Captain VANDER-MEULEN, R.N.: I can speak from some little experience upon this subject, for, having commanded a ship the last four years in the Naval Manœuvres, I have found that whenever the ship is required to go at any special speed, the Chief Engineer always came up and complained, particularly if the coal was difficult to get at, that the staff must be increased, not so much that the numbers were short, but of the inefficiency of the men on board, that their training was not good, and that the second-class stokers were not to be counted on in an emergency. Another thing is that the men are not put through their drills. There has been a great deal of talk about it of late years, but there has been such a scramble that we have not been able to get the second-class stokers to pass their rifle, cutlass, and gun drills. I think the engineer Officer understands now most thoroughly that a man who has been put through those drills is disciplinized, and it is of great advantage to the Service, even though he may not have done his torpedo drill. I quite agree with the lecturer as to the importance of having a school of instruction for stokers. Mr. Edwards would like to have two or three, but that is a matter of expense. To begin with one, I think it is high time that some school of instruction should be established for stokers, and the idea the lecturer has given us of the way it should be done I think is a very perfect one. There is also the question as to second-class rating being given to the stokers. My experience when I have been

on a station has been that no vacancies have arisen, and the result is that an immense number of stokers who should have been leading stokers years before have not been rated. I think it is very important that a second-class rating should be given to stokers. One thing in which I do not agree with the lecturer is in our wish to make the Navy elastic, and more particularly the engine-room branch of the Service. The way in which the engine-room branch of the Service can be made elastic is by letting the men go when they have completed their time—twenty-one years—because in case of war or in emergency we should fall back upon the last five years men (pensioners I mean). Therefore we want to have men constantly going through training. I know that for engineer Officers themselves it is much better to have a man who has been through the mill, but with a view to the requirements of the Service we want to get a large body of men trained. And with that in view when I commanded a ship that had no masts, on the coast of Scotland (the "Devastation"), whenever any Coastguardmen were required, I always wrote to the Admiral and requested that stokers might be sent, because we want to make the Navy elastic in that way, and we want to have more stokers in the Coastguard than we have at present. Another thing to be considered is with regard to the Royal Naval Reserve. They will be in future the backbone of our Service, and I think there ought to be a much larger proportion of stokers trained and brought forward in the Naval Reserve than there are at the present moment.

Admiral BOYS: My only object in rising is to ask one or two questions, as to which I am sure the lecturer will enlighten us if he can. The first is whether, regarding the Manœuvres of 1890, it is the fact that the reports made by Captains were to the effect that the duties in the stokehold were performed satisfactorily. I am given to understand that that was so. Reference is made by the lecturer, quoting from Lord Brassey, as to an Italian training ship for stokers. Is it not the fact that that training ship is now abolished, as it was found not to be worth the expense incurred? With regard to the comparison as to the pay of merchant-ship stokers with R.N. stokers, is it not the case that the pay, with pension to follow, of the Royal Naval stoker exceeds the temporary amount of high wages that the merchant stoker may earn?

Admiral COLOMB: I should like to endorse what Admiral Cleveland has said as to the gratification it must be to members of this Institution that Mr. Langmaid has come forward with this paper. It is just what the Institution desires, and I am sure the Navy will feel that he has done the Service a good turn in reading it. The proposals have the ring of reasonableness and knowledge about them. As an old Steam Reserve man, I have been confronted with many of the difficulties that the lecturer has spoken of, and, without question, if the schools can be established, such as he proposes, the stokers would be very much improved in every way. I was particularly struck with the proposal to train the young stoker in firing by means of McAdam stones, throwing them into a model furnace constructed for the purpose. It seems to me that you would get men very well trained in that way, as a beginning, at a very small cost. I think the paper read is rather a sign of the times; it means that we are no longer going to treat the stoker as a different being from the seamen. In old times we used to think seamen were the only necessity, and that stokers were—well you might get on either with or without them—but they were not so important. The disappearance of masts and sails has convinced us that stokers are now a part of the ship that it is impossible to dispense with, and are on the same level, as far as the necessities of the Service go, with the seamen. For many years in the past it has struck me that we ought to enter our stokers in the same way that we enter our seamen; and I should have no hesitation myself in training seamen and stokers together as boys, in the way the young seamen are now trained, and then, when they get to a certain age, say seventeen, that those who volunteer for stoker rating should go under the special training that is suggested. I think we should consider how important it is to get rid, as far as possible, of the distinctions which grew up when steam was fighting against sail, amid all sorts of difficulties and hindrances.

Admiral BOWDEN-SMITH: The Navy is now going through a very great change. Up to the present moment we have been holding on to our masts and sails. It was authoritatively announced last year by the First Sea Lord that they are hence-

forth to be abolished, and, therefore, it behoves us very seriously to consider, now that steam is the only motive power, how we are to get good stokers and how they are to be trained. A paper of this sort, written by such an excellent Officer as the lecturer, is certainly worthy of every consideration under these circumstances. There are one or two little points upon which, however, I may offer friendly criticism. My friends Admirals Colomb and Cleveland say that we ought to do all we can to bring the stokers and bluejackets together. With that opinion I most cordially agree; but, if this plan as proposed by Mr. Langmaid was carried out in detail, it would not produce the effect we desire. Instead of having a separate establishment, in the first place, I would rather see the stokers entered as they are at present at the naval ports. At Plymouth, for instance, there are large barracks, and there they would be able to carry out the drills as proposed by the lecturer, under the gunnery instructors, in sheds, or be exercised in boats, &c. Instead, therefore, of having a separate establishment, I would rather see them trained in that way. As to sending them out in cruizers, I always have been rather against herding men together, thinking that the younger men learn their duties better when put with their older fellow-workers. It may be argued that, when working in that way, the junior hands are put on one side to trim coals, and sent out of the way when the pressure comes, and so never become competent. Perhaps that is the reason that the lecturer asks for separate cruizers, so that every man shall have a chance of being taught stoking and other important details. For my part, I would rather, if possible, keep them working with their brother bluejackets, because by that means we should train them together. Some very sensible remarks were made about teaching them knotting and splicing, and that brings me back to something which occurred on board the "Britannia." I remember once, when the question of knotting and splicing was discussed, some one referred to gammoning the bowsprit as one of the useless things taught. Of course, that is just nonsense; but knotting and splicing are not only useful to the naval Officer and bluejacket, but equally so to the stoker. I can quite understand what Mr. Langmaid said, that when he had a job of lifting a piece of machinery, taking off a cylinder cover, or anything of that sort in a difficult corner, he has found that a stoker who had been a bluejacket was the most handy man for doing that particular kind of work. Therefore by all means let us have a little knotting and splicing instruction, fitting tackles, or any other work of a like nature tending to make a man useful and handy. With regard to the question of training stokers, I should like to ask Mr. Langmaid if he knows of any system at all for the instruction of the stokers for the merchant service, or whether they go straight into the mercantile marine. I happened to go out last winter in the "Teutonic" to New York, and going into her stokehold was very much surprised to see the exceedingly confined space in which the men had to work. I only wonder that they get men to do the work in such a confined space. Mr. Langmaid referred to the difficulty of getting stokers; that it was not a very pleasant life. I can quite understand that. It is very different to what it was a few years ago. We who have been in cruizers know that we often performed a great many of our voyages under sail, and in many ships steam was only raised once a month for target practice, so that the stoker had a very good time of it. Now, when under way, ships are always under steam, and when they are in harbour, the stokers have to coal and clean the engines and boilers. I think we ought to consider what we can do to make their lives as comfortable and as little irksome as possible, and to be particularly careful not to take up their spare time in unimportant matters, because their life is really a very arduous one.

Admiral Sir WILLIAM DOWELL: There is one thing with reference to what Admiral Bowden-Smith has said. On first entry, stokers go straight to the naval barracks; they go through a training for three months, and are kitted up and drilled, and everything of that sort, before they go to the "Indus" at all, in fact, before they become stokers. I certainly think it is a move in the right direction which brings them more in contact with the bluejackets, instead of starting them as entirely raw hands when they go to sea, as though they had not been in a man-of-war before, or only in a ship like the "Indus," where there are 1,800 of them. Of course the comforts are not so great, because they all live on a ship, but they get into the habits of a man-of-war, and it is not so bad for them when they go to sea

afterwards. I am sorry I was not here to hear the paper read, but I am sure from what I know of the author, it was a very good one.

The CHAIRMAN: Mr. Langmaid has some letters from experienced Officers of the present day occupying at present very high and responsible positions, and, as a general rule, they entirely agree in the importance of the subject which he has brought before us.

Chief Engineer EDWARDS: If I may be allowed to make one other remark, I should like to say another word as to the necessity of instituting some kind of annual or periodical Engineer Report for the Navy, which the lecturer describes as the want of an Engineer Intelligence Department. We have found this want a very great one. I was away some time ago in a small vessel, and during my absence I entirely lost touch with modern engineering for the time I was away. The ship I was in was fitted with simple machinery, and I had no opportunities of seeing any other ships. I must say, when I came home, after an absence of two or three years, it seemed to me that engineering was quite another thing altogether from what it was when I left England. I think if we had some kind of annual report—if every engineer Officer in charge of machinery in the Service had to furnish a report—to offer suggestions, resulting from their experience of the new machinery under trial, those reports might be embodied in an annual report, which might be issued for the information and guidance of every Officer of the Fleet. We have a lot of new machinery, new distillation machinery, electric lighting machinery, hydraulic gun and torpedo machinery, and so on, constantly being added to the Fleet, that very few of us have a chance of getting much knowledge of, unless we happen to be serving at home and can get into a gunnery or torpedo course. I am quite sure some such report as the lecturer suggests would be of very great advantage to the Service, especially to the engineer department.

Admiral CLEVELAND: Might I say I would urge that this should be done through the Journal of this Institution, in its monthly issues, with assistance from the Admiralty? We want not only information connected with engineering, but also with gunnery and torpedo work, ship trials, and such other matters as are not confidential. The Intelligence Department has a great scope of usefulness in this respect.

The CHAIRMAN (Admiral Sir W. Houston Stewart): I think it must be a subject of gratification to Mr. Langmaid that he has brought forward this subject, for I suppose few papers have been read in this Institution which have been more generally concurred in, on the whole, by those who have heard the paper and discussed it. It is evident that the present state of the steam Navy is not efficient, and that it requires a good deal to be done to bring it into that state of efficiency, I admit exceedingly difficult in the present age to attain to, but still absolutely necessary. I cannot conceive anything more important than the efficiency of the stokehold and the engine-room, because if those departments are not efficient neither guns nor torpedoes can be used as they should be. Anything that an old Officer can say is only of use when he speaks of the experience of the past. If an engineer Officer, when I was a younger Officer, had given a lecture or read a paper on our steam Navy he would have told you what was the truth at that time, that the Royal steam Navy was the most efficient in the world, that our engineer Officers, our stokers, were, for the steam work required at that time, the best afloat. At the time I entered the Navy, and some time afterwards, the engines of the French Navy generally were in change of English engineers. I served as a Mate in a steam ship, as a Lieutenant in a paddle steam frigate, and I have commanded four steam ships, and in those days the finest men in the crews of steam ships were the stokers. When the Admiral mustered the ship's company, as the stokers passed round the remark was, "What fine looking men!" The Engineer had every appliance at hand that he required for lifting work in his engine-room, and he had seamen among his stokers to use it. So popular was the stokehold in those days, that the best seamen, as soon as there was an opportunity, volunteered for it, petty officers also. In the steam ships I commanded, our stokers were amongst the finest men in the ship, and it was my pleasant duty, when I had the opportunity, to compliment the engineer Officers and stokers on the efficiency of the stoking and the working of the engines. You will say, very naturally, we require a very different sort of thing

now to what we did then. So we do, but we have not kept up to the wants of to-day. We required it at that time for what was the steam power as much as we do now; it was kept up, and our steam Navy was the most efficient of all. That we have not kept it up to our present requirements Mr. Langmaid and other gentlemen who took part in the discussion have clearly pointed out, both engineer and executive Officers. I therefore agree in what Mr. Langmaid has in this paper called attention to. There may be differences of opinion as to the various details, but still the necessity is the want of a system of training for our stokers. The modern war ship has been appropriately termed a "steam being." As it is necessary to enable the human being to move, to walk, or to run, that the heart and its functions be kept in a perfectly sound condition, more especially if there is any abnormal demand for unusual exertion and endurance, so, in the "steam being," the human and mechanical appliance for raising, for keeping up, and for directing the steam must be thoroughly understood and intelligently worked. Hence the great importance and value of the subject which Mr. Langmaid has so ably treated.

Mr. LANGMAID, in reply, said: I must thank the Chairman and the Officers present generally for the support they have given to my paper, and for the interest they have taken in it: I am sure I hardly expected to have so much support. I certainly think that as the necessity for training aloft in our ships becomes less, the necessity for training below becomes greater: and that the cost of training suggested would be amply repaid by the consequent saving of coal, to say nothing of other advantages gained. One gentleman has told us that seamen and stokers should be more interchangeable. I have stated my objections to this previously, and I still think that seamen gunners, with skilled gunnery and torpedo men generally, should, with chief and leading stokers and the suggested second-class petty officer stokers, be regarded as specialists in their own particular lines, and be kept to them. At the same time, it is possible that the lower ratings of seamen and stokers might be interchangeable, but I should not advocate any change in that direction. Mr. Stewart has told us that he considers the time I have suggested to be spent in the harbour training ship (three months) too long, and that one month would be sufficient. Considering the work these men would have to learn, three months would be none too long. No man could be expected to become proficient in the practical work suggested, to say nothing of skilful, in less time: while anything requiring an exercise of the memory would have to be gone over at least twice. Again, these men enter, as a rule, in very poor physical condition, and require at least three months building up to fit them for work at sea. Admiral Cleveland, I think, misunderstood me slightly in the contrast I drew between the training of the military part of the ship's company and the propelling part. I think all the money spent in training seamen and marines is a good investment, and that we get a splendid result from it. What I meant to show was that, although there were a great many training ships and establishments for the purely military part of the crew, there were none whatever for stokers, who have to get their training in a most haphazard sort of way; that is the contrast I wished to point out. Of course the duties are very distinct, but each has its own importance. The military man has to fight the ship, but he cannot do this unless the propelling man has it in his power to put the ship near the enemy; and it is in this direction our weakness lies at present. Captain Vander-Meulen has spoken of the advantage of having a reserve of stokers who might be called out if necessary. I think if we have such a reserve it should be in the Coastguard, so that the men could be kept thoroughly in touch with the Service and its requirements, and that if a man drops out for five years he is not of much use except for ordinary routine duties on his return. I had experience in 1885 of pensioner stokers who were called up for service, and from various causes only about half of them were of any real value. There are so many changes now in five years that a man, however good he might be, if unemployed for that time, would not be reliable as a specialist if called up for a sudden emergency.

Captain VANDER-MEULEN: I need hardly observe the great idea is to have all the Reserve ships perfectly efficient, and we want the men there. At the present moment there is a squadron of thirteen.

Mr. LANGMAID: With that last point I quite agree, and suggested that more men should be put into the Coastguard, of course when they can be spared from the Fleet. What I did not agree with was the idea of men being kept so long as five years away from sea-going ships.

Captain VANDER-MEULEN: But that hardly applies to the men I was speaking of, namely, the district ships and Coastguard. There are a certain number of stokers in the Coastguard that go on board their district ships. The Chief Engineers are most glad to get two or three of these men as leading stokers before going into the Coastguard. They like them better than any one. They know their ships; they are embarked every other year, and very often every year. I can only say in our own district we had about ten stokers embarked every year, and there were two or three men who had held the rating of leading stokers before going into the Coastguard, whom the Chief Engineer was very glad to have. They understood the ship of that district, that is what I mean, that you want to have people passing through constantly. If you want to increase the Navy, you will call out probably your last five years pensioners, and among these men you will have a lot of stokers that are very efficient. Therefore, do not keep them after they have completed their twenty-one years.[1]

Mr. LANGMAID: The point I wish to make is this: that a man should be kept thoroughly in touch with the Service. If you take the ship I am now serving on, one of the new cruizers building under the Naval Defence Act, she is fitted on deck with rapid-firing guns, and below with triple expansion engines, and many other new arrangements which were not thought of in the Service five years ago, so that a man who had not served at sea during that time would have to learn a good deal on joining such a ship, whereas he would have a better chance of keeping up his knowledge if serving in the Coastguard. Admiral Boys has asked if there were any complaints as to stokers during the last Naval Manœuvres. I do not think there were any complaints made in the Official Report. But I have spoken to several of the engineer Officers in the ships engaged, and they all had a very anxious time; which must have been the case with complements made up largely of totally untrained men, some fresh from the shore. It must be remembered, too, that there was no chasing or full-power running as in previous manœuvres, except for the torpedo-boats: which always carry trained stokers. The question of the pay of stokers has arisen, and we have been reminded that their pensions should be taken into consideration. Of course a man gets a pension if he serves his full time, but from various causes there is a great waste amongst stokers, and a large percentage of those who enter do not get pensions. Again, as the Chairman suggests, young men when joining the Service seldom look so far ahead; they think more of the immediate advantages they may get. Admiral Colomb has spoken approvingly of my suggestion as to instruction in the use of the shovel in the proposed harbour training ship; an incident has recently come to my knowledge supporting this suggestion. The day before yesterday I was talking to the Chief Inspector of Machinery of the Portsmouth Steam Reserve, and he told me what had come under his notice that morning on board the "Howe" while on trial of her machinery. He saw a young second-class stoker using his shovel very awkwardly and at a disadvantage; he told the man the proper way to set to work, with the result that the man held his shovel the proper way and immediately did his work very much better. Now, I consider it is hardly the thing that a Chief Inspector of Machinery should be under the necessity of teaching stokers their work; and such

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[1] I rather think, on looking over this, that the lecturer and I were driving at different ends. His argument is that when they have completed their first ten years' service towards pension, a further inducement should be given them to serve on and complete their twenty-one years for a pension; in this I agree with him, if it is given to the other branch of the Service (I mean bluejackets), and I was arguing, that after their twenty-one years' service I should let them go while they are physically strong, because I wish the last five years pensioners to be in their zenith, as I imagine, in a case of war, we should call them out, and wish to find them, both in age and physique, men in their prime.

a thing could not occur if men were properly taught as suggested. A suggestion has been made as to the advantage of training stokers and bluejackets together up to a certain point; then letting the men choose which they would like to be, and complete their training for either rating. I am afraid that this would be unsatisfactory from an engineer's point of view, as the best men would probably prefer to take bluejacket ratings, as thereby they would be enabled to rise to Warrant rank, which would not be possible if they chose to be stokers. I think we should take men as they come at present, as thereby we get a fair average of good men. Admiral Bowden-Smith has said there is a disadvantage and a certain objection to a lot of men being congregated, as they must be, in any case, if trained collectively. I consider the advantages, however, outweigh the disadvantages. At present some men go to sea with Officers who make it a point of seeing them properly trained; others, again, go with Officers who do not take so much interest in that part of their duty. The result is, these men do not go on so well; "What is everybody's duty is nobody's duty." This kind of thing would be obviated if all men were trained in a special ship by special men; and if the men did not turn out well, they could be discharged to the shore. In the Naval Service we ought to be able to get the pick of the labouring men in the country. Admiral Bowden-Smith also asked about the instruction firemen get who are employed in mail steamers. As far as I have found, at Liverpool and Glasgow these men come largely from "tramp" steamers, where they learn their work first as trimmers, then as firemen. In these ships, also in most of the mail steamers, there is a much greater reserve of boiler power than in a war-ship, so that the necessity for good firing is not so great; and men learn their work under easy conditions. A ship like the "City of Paris" carries 54 firemen and 54 trimmers, besides leading firemen, oilers, donkeymen, storekeepers, &c. The trimmers possibly take turns on the fires, and in the course of time become regular firemen. In our Service every man in the stokehold should be a good fireman. Captain Durrant has informed me that there are now 333 stokers in the Coastguard, to be increased to 446. These numbers are still much below the proportion of stokers to seamen in the Fleet, and could, I think, be raised with advantage when good men can be spared. He also informs me that there are 560 firemen in the Royal Naval Reserve, to be raised to 700. Evidence was given before the Select Committee of the House of Commons in 1888 that great difficulty was experienced in getting these men to join the Royal Naval Reserve. At that time only 337 firemen had joined, against 9,489 seamen. These men, and hundreds more, would be required to join mercantile cruizers in war-time, and even if put on board war-ships, they would only be useful as firemen, and not be good all-round men below, such as are wanted. The Chairman has told us what fine men stokers were many years ago. I can only go back twenty years, and can remember that the men we had then were much finer, physically, than those we get now. The mercantile engineer selects men from among the firemen for the higher ratings, and makes the more intelligent men "oilers"—that gives a man another 5*s.* to 10*s.* per month. Perhaps the next trip the man takes he is a fireman again. The oilers again are promoted to "donkeymen," which gives another increase of pay. Our good men, leading stokers, &c., are good all-round men, and that is what we require in the Royal Navy.

The CHAIRMAN: In the Merchant Service the engine-room staff is divided in this way, is it not: there are the trimmers, the oilers, the store-keeper? There are certain people who do not come under the head of stokers altogether, but have certain special duties to perform as they do in the Navy. If not would it not be very much better it should be so, because an inefficient fireman might make a very good oiler? You would have no distinction of that kind?

Mr. LANGMAID: No, I do not think we should have. I think a good stoker who is a good intelligent man would be a good all-round man. When a ship carries two second-class torpedo-boats or steam boats, these men must be looking after the auxiliary engines at sea. In harbour they would have to go to the torpedo-boats. You must work these men at sea; they are very good men.

The CHAIRMAN: Perhaps they would give you enough to meet all the requirements.

Mr. LANGMAID: They won't do that.

The CHAIRMAN: These men in the merchant service never do stoke. Very often in winding up these interesting and profitable discussions the Chairman says there is a good deal of difference of opinion; but I do not think there has been very much difference of opinion on the subject that Mr. Langmaid has brought before us. The necessity for it has been certainly concurred in. There may be a difference as to matters of detail, but the whole principle of what Mr. Langmaid so ably described has certainly been concurred in here. I am sure that we shall all concur in expressing our pleasure at seeing Mr. Langmaid here as an engineer, and our hope that the engineers will bring forward their subjects here, and that they will be freely discussed. We must also express our thanks to Mr. Langmaid for his interesting paper, which has afforded us a most pleasant and profitable discussion.

Friday, January 16, 1891.

REAR-ADMIRAL P. H. COLOMB, Member of Council, in the Chair.

STEEL, AS APPLIED TO ARMOUR-PLATES.

By CHARLES WESTON SMITH, Esq.

BEFORE passing to the subject upon which it is my privilege to be permitted to speak, it will be well for me to premise that in all of which I shall treat I speak solely from the standpoint of a steel manufacturer, of one who has had a practical and prolonged acquaintance with steel, its nature and properties, and of most phases and conditions of its manufacture and uses. It is my thorough familiarity with it, and consequent entire confidence in its trustworthiness and remarkable capacity of adaptability, which conquers the diffidence I must naturally feel in addressing those who are my superiors in wisdom, knowledge, and experience.

I must ask also for a patient tolerance of what may seem a reiteration of known facts. It is inevitable that much old ground should be gone over in treating of any proposed substitution for existing use. And this is more especially the case when, as now, steel, in one or other form of constitution, is so largely employed in armour-plate manufacture, and when the scheme which I shall present to you differs from others only in the details of its constitution and a joint process of its production.

Steel has now so completely won public confidence, and so triumphantly vindicated its own merits, that it is almost curious to recall an impression which prevailed in early days of the manufacture, that steel was unreliable, uncertain in its nature, as, for instance, when, in the year 1875, a high authority referred to steel as "an extremely touchy sort of material, something like flint glass, which would not break, although it was thrown down six times, but, perhaps, if it were thrown down a seventh time, it would fly all to pieces," a criticism which, in the light of present day attainment and knowledge, is ludicrously inapplicable. If there ever was any ground for this belief in what was called the "capriciousness" of steel, it has long ceased to have any basis in fact. The knowledge and skill since brought to bear on its manufacture and treatment were in those earlier times comparatively little advanced—the high-water mark of attainment then being its low-level in these highly favoured days of ours—and as at that time the strong light which beats upon a new claimant to prominent use and scientific esteem was focussed upon it,

the few failures which then attended its development were dwelt upon and exaggerated.

Perhaps we may best attain to the appreciation of the excellencies of steel by comparing them with those of iron, which they surpass. "Steel is of much higher nature than iron. It is much stronger, and can be made to possess nearly any degree of strength, hardness, and ductility, within wide limits, that it is desired to give it." Steel is, according as it is constituted, harder than iron, as soft as iron, tougher than iron, stronger than iron. In the property of hardness it is capable of enduring a strain of as much as four times the ultimate strength of iron, and, while sharing in an equal degree with iron the property of softness, possesses at the same time an enormously increased ductility, as represented by its extension in a given length before fracture. "It can be modulated," says Sir William Siemens, "to every degree of ductility, approaching the hardness of the diamond, on the one hand, and the proverbial toughness of leather, on the other." In illustration of this point of ductility, I may allude to an interesting series of experiments made some years ago by the late Mr. Daniel Adamson, with a view to ascertain the comparative resisting powers of iron and steel to concussive force. "The iron plates tested were of the best quality, and the steel plates of a mild class, suitable for boiler and shipbuilding purposes. All the iron plates subjected to explosive tests were 18 inches square by $\frac{7}{16}$ inch thick, placed upon a cast-iron anvil block, about 20 inches square, having a segment of a sphere gouged out on the top side, 10 inches diameter and 4 inches deep. 12 inches above the plate, 3 lbs. of damp guncotton were fixed by a tripod of laths, attached to the cotton by two india-rubber rings. Upon this, again, was placed 2 ozs. of dry guncotton, with a time fuze attached, to ensure a complete explosion of the damp compressed cotton. On the guncotton exploding, the iron plate was entirely broken through, 10 inches in diameter, and a centre-piece forced down to the bottom of the anvil block, breaking up in an irregular line in the direction of the fibre, and to some extent across it.

The same experiment, precisely, was conducted on a steel boiler plate, only $\frac{3}{8}$ inch thick, which, after the explosion, with the same weight of guncotton, and under exactly similar arrangements, was depressed 3 inches into the recess of the anvil block without the slightest sign of fracture, or any apparent injury whatever. The experiments were repeated, with the same result, on five more Best-best iron and five mild steel plates, the latter being both of the Bessemer and Siemens system of manufacture. These experiments, therefore, were conclusive in favour of mild steel to resist violent concussive force."[1]

Steel, again, is homogeneous, and is thus capable of a perfect uniformity in endurance of strain throughout a large mass, having in this count greatly the advantage over iron, which, being fibrous, has necessarily an unequal and partially balanced distribution of tenacity

[1] Jeans on "Steel: History, Manufacture, and Uses." (Spon.)

and ductility under strain. This variation in strength comes out conspicuously in the manufacture of plates of a great size, such as armour-plates, and, owing to the homogeneity of steel, does not exist in steel plates.

This superiority of steel over iron, and its excellence *per se*, which I have thus attempted to demonstrate, brings me to my first point—the application of steel to armour-plates—armour-plates constituted wholly of steel. I do not, in saying this, ignore the fact that wholly steel armour-plates are already in the field; rather it is my purpose to draw attention to the fact of their having had a tolerably successful campaign, and to suggest the application of a principle to them by which it seems to me their efficiency may be increased—and that is graduation of constitution.

There seem to be two diverse principles which may severally be taken for guidance in framing the constitution of an armour-plate: (1) that of pure resistance, and this seems to be met by an identity of constitution throughout; (2) (and this is apparently the *rationale* of the compound plate in existing use in our Navy, *i.e.*, one-third hard steel face and two-thirds remaining iron back) hardness of face to resist the first impact of shot, and softness of back, with the purpose, according to one acceptation, of holding the plate together under fracture of the face; or, in the more purely scientific view, to occupy and expend the residual energy of the shot. It may not be uninteresting, or out of place, to quote on this head some words of Dr. Pole in reference to the work of the Iron Armour Committee: "People thought generally that the way to keep shot from entering a vessel should be the same as would be applied to keep a burglar from breaking into a strong box; namely, by protecting it by a covering extremely hard, and therefore supposed to be impenetrable. Hence, the hardness of the iron, or supposed impenetrableness of the steel, was assumed to be the great object to be attained.

"The Committee strove earnestly to explain that this was a great error. The action of a burglar and of a shot were shown to be incapable of comparison with each other, the one being a static, the other a dynamic, action. When the shot arrived, there was 'residing in it,' according to Dr. Siemens' expressive phrase, a very large amount of mechanical power or energy which *must be expended* in some way or other. It was, therefore, folly to attempt to resist it—to shut it out. The proper way was to accept it—to receive it, and to make provision for its being expended in the least harmful way." In conformity with this principle, the Committee "offered something for the shot to do; they provided plates, not of hard steel, but of soft iron, which would admit of being battered about without fracture, and so would occupy and expend the energy of the shot while still protecting the vessel."[1]

It would almost seem from the established use of the compound plate, with its soft iron back, that the principle at that time enunciated and emphasized had been in part, and, at least, practically,

[1] "Life of Sir William Siemens." (Murray.)

conceded and acted upon. Of course, the compound plate is an illustration, though in a limited and comparatively inefficient degree, of the principle of graduation. My contention is that its aim and function may be much more perfectly fulfilled by the substitution of pure steels of varying temper—an armour-plate wholly of steel of graduated qualities in combination as one perfectly blended whole—for the compound plate of iron and steel.

The fact is incontestable, so far, at least, as we have yet advanced, that absolutely invulnerable armour—armour that is wholly impervious to the impact of projectiles—is a simple impossibility. M. Schneider, after allowing that "a compound or steel-faced plate has peculiar power to break up projectiles of *medium* quality, because the face is formed of extremely hard steel," goes on to say: "projectiles are now, however, made—such as those of chrome steel—which are more than a match for the hard 'face-plate';"[1] inferentially, since the highly carburized face-plate is the hardest material possible for such a use of any surface whatsoever. M. Schneider adds subsequently: "This face-plate once overcome, the resistance of the soft back is small compared with that of solid steel." Necessarily, and not disadvantageously, because its aim and function are not that of resistance, but of *receptiveness*. Since, then, you cannot have armour which shall be absolutely shot-proof, the next best thing is so to constitute it as that the unavoidable damage shall be reduced to a minimum. A steel armour-plate, *graduated in its constitution*, would, in my belief, best ensure this.

The manner in which I propose to carry out this principle of graduation in an armour-plate is by casting varying and sequentiated tempers of steel simultaneously into one ingot mould, so constructed in subdivisions as that the varying tempers shall be preserved each in its integrity, while yet each shall so combine with the other as to form a perfectly graduated whole, the rolled steel partition-plates which subdivide the mould constituting by their previously determined qualities intermediary tempers in the final graduated steel armour-plate ingot.

In order to the obtaining of an armour-plate of maximum efficiency—the requisite properties being tough-hardness of face graduated to extreme softness of back, combined with the chemical desideratum, purity of metal—it seems to me desirable so to proportion the increments of carbon in the sections, as that their tempers shall graduate consecutively, as follows:—

A very soft back-section of the lowest possible tenacity, containing, say, 0·08 per cent. carbon or less;

Then comes the first partition-plate, containing about 0·2 per cent. carbon;

Next, a mild mid-section of from 0·25 per cent. to 0·35 per cent. carbon, blending into

The second partition-plate, containing about 0·4 per cent. carbon;

And, lastly, a hard-tough face-section of from 0·5 per cent. to 0·65 per cent. carbon.

[1] "Engineer," July 12, 1889.

All these so blended as to constitute one perfectly indivisible whole.

Mechanically, we have in this graduated plate ingot a hard-tough face, possessing an average ultimate strain of, say, 55 tons per square inch, with ductility as represented by the final extension in the 8-inch length of about 10 per cent.; fused into a mid-section of, say, 36 tons per square inch ultimate strain, with an extension of about 20 per cent.; fused into a very soft back of about 20—22 tons per square inch ultimate strain, with a final extension of, say, from 35 to 40 per cent. in the Admiralty 8-inch length.

As compared then with the compound plate in present use, the points of advantage possessed by a steel plate, constituted as I have suggested, may be thus enumerated:—Mid- and back-sections of mild and soft steel respectively, the former possessing as much as double the strength of good iron (of course taken lengthwise), with a greater degree of ductility: the latter having twice the ductility of good iron with about the same ultimate strength. Put briefly, we have an average gain in strength and ductility of the mid- and back-section steels over the iron back of the compound plate (which they are proposed to substitute) of *at least* 40 *per cent.* In fact, the gain is greater, for this calculation does not take into consideration the variations in strength of the iron, which result from its fibrous character and the consequently unequal and partial distribution of tenacity and ductility throughout its bulk, as compared with the homogeneousness of steel and its proved regularity of strength and perfect uniformity of endurance under strain throughout, however large be the mass treated. This quality seems to me to be an element of crucial importance in favour of the case for steel.

As for the disadvantage sometimes urged against this homogeneousness, viz., that it lends itself with facility, or, at least, that it presents no obstacle, to "through cracking"—that under concussive strain its tendency is to carry into still further penetration the initial crack—the principle of graduation would, I believe, be an effectual antidote to any such tendency. Because, as far as my experience serves me, the crack in the face-plate will not extend unbrokenly into the contiguous quality, having a different and lower ultimate strain. A break of continuity in the structure of the metal would result in the interruption of a fracture at the line where the quality of metal in which it started ends: the result being that its further extension would be stopped. Under ordinary pressure it certainly would. But assuming that, under great concussive strain, it did penetrate the successive qualities in one forward crack, it would, in the graduated plate, inevitably lessen with the reduced ultimate strains of the tempers of steel through which it was passing, and would simply develop into a tension on the back. I may be permitted to quote from the "Naval Annual" of 1890: "Experience has shown that, whatever power of extension metal in a plate-back might have, it would only exercise it under the impact of shot *if its tenacity was low*—otherwise it would break through in preference to stretching. . . . Repeated experiments have been

made with 'foundations,' or backs of soft steel or wrought iron in which high tenacity and high elongation were combined; but, in spite of the good resistance offered, the tendency to 'through cracking' was held to be a reason for condemning the plate." Now this element of high tenacity in the constitution of the plate-back is precisely the cause of failure which, I think, the principle of graduation is calculated to remove. High tenacity with high ductility are indispensable properties in the constitution of the face; but high tenacity is a virtue misplaced in the back, where the lowest tenacity with the highest ductility is an element of fundamental importance. In an iron plate there is, as I have said, low and irregular tenacity, with greatly inferior ductility. This, taken together with the other points, in which steel possesses so undoubted a superiority, must, I think, be acknowledged to constitute a strong claim to consideration and preference.

I lay great stress on the purity of the steel, as, in order to produce a specially fitting and able material, as total an expulsion as possible of all impurities must be ensured. There is no inherent difficulty in the attainment of this ideal metal. In dealing with its chemical constitution, I will simply state the means by which I believe the impurities existing in ordinary steels can best be eliminated, and an approximately pure metal ensured.

By an approximately pure metal I mean a practically dual alloy of iron and carbon, only sufficient manganese being present to impart the necessary forgeability—carbon, as I need hardly say, being the differentiating or individualizing element which imparts to steel its characteristic properties. Of manganese it may be said that, though in itself an impurity, it cannot, as yet, in the manufacture of steel, be treated as such. Its action may be described as the toleration of impurities by means of an impurity; its function being to impart forgeability, and so to act rather as a neutralizer in the presence of the impurities, phosphorus and sulphur, with their phenomenal cold and red short properties, than as an agent of their expulsion. The *modus operandi* of manganese, or by virtue of what property in itself it effects it, are yet matters of speculation. Speaking here, in March, 1879 (since which time, outside the field of special alloys, scientific investigation has arrived at no opinion in contradiction to his view), Sir William (then Dr.) Siemens said: "Manganese, though very efficacious in hiding impurities in the steel, is in itself an impurity inconsistent with high quality in the material produced. It is important, therefore, that steel for war purposes, where high temper and tensile strength are required, should be practically free from manganese, as well as from all other admixtures with the sole exception of carbon. Extra mild steel, which is so remarkable for its extreme ductility, should contain in 100 parts 99·75 parts of metallic iron, and only 0·25 per cent. of all foreign substances put together." As yet, however, we cannot dispense with manganese, though, with increased perfection in the methods of working, its use is gradually lessening. The other impurities in steel—to the deleterious effect of which, when existing in certain percentages, the presence of manganese is an antidote—are

phosphorus and sulphur, averaging in ordinary high class steels from $\frac{35 \text{ to } 50}{100}$ths per cent.; the expulsion of the phosphorus being a matter of the utmost importance, as its presence in any appreciable quantity renders the metal useless through brittleness.

The method which lends itself with remarkable effect to the purifying of the ordinarily termed pure (*i.e.*, Swedish or hematite) pig *irons, and* consequently to the effectual elimination of these two inimical metalloids, phosphorus especially, is the Siemens-basic process. Having for its primary object the utilization for steel of highly phosphoric pig irons, *a fortiori*, the result of its action on the ordinarily pure pig irons is the production of a very pure steel. The distinguishing feature of the basic or Thomas-Gilchrist process, as, perhaps, I need not say, is the application to the furnace or converter of what is termed a "basic" (*i.e.*, ground dolomite or magnesian limestone) lining or bed, in place of the ordinary "acid" (*i.e.*, silica or ground ganister) lining, together with successive additions (up to about 20 per cent.) of burnt lime to the charge of molten metal during the process—the two strong bases, lime and oxide of iron, exercising a very effectual dephosphorizing, and to a large extent also desulphurizing, efficacy. The value of this process, as allied to the Siemens furnace (which alliance constitutes the Siemens-basic process), cannot well be overestimated, as one of the pre-eminent merits of the Siemens furnace is the ease with which it lends itself to the working of large masses of material, such as armour-plates. In thus asserting the great suitability of the Siemens furnace for the manufacture of the graduated plate, I do not say the same result cannot be arrived at by the other great modern processes, but in my belief it is most easily and infallibly attained by the agency of the regenerative furnace.

For this idea of graduated constitution in an armour-plate, which I have laid before you, I do not claim the merit of novelty. In 1877, Sir William Siemens patented a "method of combining together iron and steel, or different qualities of steel, so as to give both tenacity and hardness to objects exposed to violent shocks;" his method of carrying out the principle of graduation in armour-plates being "by pouring a harder metal in the fluid condition upon a metal of milder temper." "The plan," says Dr. Pole, in his Life of Sir William Siemens, "was never brought to trial." It is a matter of much regret that it was not; whether looked at in the likelihood of its practical success, or as an experiment of more abstract scientific interest.

A valuable aid to effectiveness in the carrying out of the principle of graduation has recently been introduced into the world of applied science. I speak of the Darby recarburization process, to which, at the outset of my paper, I alluded as a joint agency of production, the use of which is one of the points of difference between my scheme of constitution and those that have preceded it. This process has for its object the recarburization of the charge of decarburized metal without at the same time introducing any foreign element, and this is of special utility where, as in the present case, the object sought to be attained is the production of an exceptionally pure steel. The

manner in which this complete recarburization is effected is by the filtration of the molten metal through a medium of pure carbon (in the form of graphite or wood charcoal). The process can be applied to both the Siemens and Bessemer systems, in either of their applications (acid or basic); and amongst other advantages obviates the difficulty which many basic steel manufacturers have so far experienced in producing the harder tempers of steel. Bearing in mind the fact that on carbon depend the essential properties of steel—that on the manner and degree of its presence depends the differentiating of steel from iron, and of quality from quality in the steel itself—it is obvious that in a process directly and exclusively affecting the question of carbon, the inventor touches the central point—the *crux*—of the whole steel manufacture. "It is a singular fact," says Professor Roberts-Austen, "that the mass of recent work, both theoretical and practical, which has clearly shown the importance of the presence in iron of elements other than carbon, and has enabled the nature of their action to be defined, has in no way lowered the position which carbon holds as the element which confers on iron the wide range of properties characteristic of steel."[1] Another feature of the Darby process which presents a facility to the manufacture of the graduated plate is that of enabling qualities of steels of varying tempers to be cast from the same charge of metal.

I now come to the mechanical features of my scheme, of which I will briefly summarize the leading points.

In the production of an armour-plate constituted as I have proposed, there would be three Siemens furnaces, placed adjacently, and working on the component qualities of metal desired in the plate,—the action of these furnaces being so regulated as that the three qualities of steel should be ready in their ladles to be run simultaneously into their respective sections of the mould. This mould (of cast iron or other suitable material) to be divided into three separate compartments, the two rolled steel partition plates (of thickness to be determined by experiment) being of tempers so calculated as that they shall form intermediary qualities in the ingot, with which, by fusion, they will finally be incorporated. We thus have, produced in one operation, a quintuply graded ingot—more than perfect in attachment (since perfection in attachment can only be said to exist where the integrity of two surfaces is preserved), a perfectly blended and indivisible whole.

It has been sometimes suggested that the point of advancement in the manufacture of steel lies in the further knowledge of its intermolecular construction and action. But mechanical work, as yet, cannot take cognizance of the microscopical structure of the steel, deeply, and to a certain extent practically, interesting as that is. The mechanical properties of a given specimen do not always perfectly correspond to the result which, from the chemical analysis, we had been led to expect. There are many limitations placed upon the work of the chemist, and the results obtained with the testing

[1] "On the Carburization of Iron by the Diamond."

machine indicate far more, as Dr. Sorby points out, the lines and planes of weakness and the divisions between the constituent crystals than the actual structure of the metal and the co-relations of the crystals.

I deeply regret the disadvantage under which I labour in being unable to present to you the practical results of my theory concurrently with the theory itself. In consequence of the uncertainty and great expenditure involved, I have so far been unsuccessful in procuring for it the test of experiment.

Of late, perhaps, public attention and enthusiasm have been rather withdrawn from other competing constitutions by the highly successful results of the recent trials of the nickel-steel plate, which indeed seems to realize the perfection of an armour-plate so far as attainment of it is at present within sight. But the success of that one does not amount to a proof of inefficiency in other constitutions, or justify their being under-estimated, and I can only, and with the utmost confidence, claim for the graduated steel plate that, if admitted to experiment, its results would equal those of the nickel alloy, though arrived at by a different road to effectiveness.

Mr. James Riley has laid the world of applied science under a debt by the practical research he has brought to bear upon the properties and treatment of the nickel alloy, and by his pioneer paper on the subject read before the Iron and Steel Institute, in May, 1889.

I am not aware if the investigations of the Special Committee on Iron, constituted in 1861, have ever been published. As late as 1885, Dr. Percy (himself one of the Committee), in his Presidential Address to the Iron and Steel Institute, said of these reports: "The results are recorded in four folio volumes. Only a small number of them were printed, but not one of them ever published. In them lies buried a vast amount of information of special interest to our iron and steel workers;" their special value, of course, lying in the fact that they are the results of practical experiment, as well as the application of scientific principles.

I trust I may not be held to have disappointed expectation by the manner in which I have attempted to fulfil the promise implied in the designation of my paper, "Steel, as applied to Armour-plates." My object has been simply to set forth the principle of graduation, in which, it seems to me, is to be found the best solution of the problem, how to combine suitability and excellence of material with the requisite difference of temper between the face-plate and the back, involved in the function each has to fulfil. It has seemed to me, likewise, an omission, no less unaccountable than regrettable, that so superior, so reliable, and so adaptable a metal as *pure* steel should not find fitting and effective application in the noblest detail of a noble use—that while steel is employed in every other available part of a vessel's equipment, it has not, *in its fullest and most perfect development*, been appropriated to so important a detail as the armour-plate.

I am regretfully conscious that my paper is open to the objection of being purely theoretical, in an application where the result of

practical experiment is necessarily the supreme and final arbiter; but I may be permitted to urge that it is not abstract theory, but a result of investigations and conclusions arrived at in the course of practical experience, and founded, therefore, on bases of fact. I hope, however, that, even if my conclusions are thought to rest on insufficient data, the principle I have endeavoured to set forth, and the method of its application which I have advocated, may in themselves be deemed worthy of consideration, and adequate to fulfil the need and function for which they are put forward. "In all our operations," says Sir William Siemens, "we should fix our eyes upon the ultimate result which theory indicates, which, owing to the imperfect means at our command, we may never completely realize, but which we should constantly endeavour to approach."

Admiral Boys: May I be permitted to ask if there is any prospect from experiment of the practicability of the manufacture of these steel plates in the form suggested by the lecturer? The conclusion that he points out to us is a theoretical one.

Colonel Baylis, Q.C.: I should also like to ask a question, upon which perhaps some member will be able to give us some information. Coming here as a novice, I was attracted because I was sure I should learn something new, and I have done so, from this very interesting paper. Will the lecturer be kind enough to tell us whether steel has been previously applied to armour-plates? I am not aware that it has been so. As it is suggested that theoretically steel can be applied, it is natural that we should ask the question whether it has ever been so applied in England.

The Chairman: I would also ask the lecturer to explain the terms he uses in speaking of the action of manganese when he says, "Its function being to impart forgeability, and so to act rather as a neutralizer in the presence of the impurities, phosphorus and sulphur, with their phenomenal cold and red short properties."

Captain Burgess: I wish to ask what the expense of such a plate as that described by the lecturer would be as compared with the ordinary armour-plate, particularly with the nickel armour-plates that we have heard about?

The Chairman: It would also be interesting to know whether one of the great difficulties of armour-plates being that they are an excrescence on the ship and give it no strength, would it be more easy to work such an armour-plate as you described into the strength of the ship?

Captain Sir Charles Craufurd, Bart., R.N.: I should like to ask whether there is any such difference between the specific gravity of the steel plates and the present armour-plates now in use as to make any practical difference to the weight applied to the side of the ship?

Mr. C. W. Smith: In reply to Admiral Boys' question as to the practicability of the casting, I have no actual experience with the casting of steel in the mass that I propose in my paper, but my conclusions are based upon investigations with regard to smaller masses and smaller thicknesses which amply justified me in propounding the theory which I have done in my paper.

The Chairman: What thicknesses?

Mr. C. W. Smith: Up to 2 and $3\frac{1}{2}$ inches.

The Chairman: You have no experiment as to resisting power?

Mr. C. W. Smith: No other than the one I have mentioned here by Mr. Daniel Adamson. In reply to Colonel Baylis, I may say that steel has been applied for some time experimentally to armour-plates in one constitution or another, but not, as far as I am aware, in the graduated constitution that I propose. It has been applied in the case of compound armour-plates since the year 1877. In those plates it is used to the extent of one-third, but that is one quality of steel containing on an average five-tenths or six-tenths per cent. of carbon. One-third of the plate is such steel, the remaining two-thirds being iron, but steel wholly has not been

applied in the Navy. The only application has been the compound plates, but I understand that some experiments have been made in the last two years in solid steel by the officials, and with apparently satisfactory results. In reply to the Chairman's question with regard to the definition of "cold and red short," when phosphorus is present to the extent of from $\frac{5}{100}$ths to $\frac{1}{10}$th in ordinary class steel, it renders it brittle; when it is cold it breaks up; if you try to bend it it will break off sheer.

The CHAIRMAN: When it is "red short" is it the same?

Mr. C. W. SMITH: No; the definition of "red short" applies to non-forgeability at high temperature. If you have an excess of sulphur from 5/100ths to 1/10th, unless you have an excess of manganese, the steel will break up under the hammer, or break up under the rolls. Whether it would work into the strength of the ship is a question that I am afraid I am not capable of answering. Then with regard to Captain Burgess's question as to the difference of the expense of nickel steel and my graduated plate, of course I simply go on data, but I shall have pleasure in giving you those data. The plates which have attained very successful results have contained a little under 5 per cent. of nickel, and the great advantage accruing from the alloy of nickel and steel is that none of the nickel is lost in oxidation in the furnace, so that practically what is put into the steel you obtain in the finished plate. To put 5 per cent. of nickel into steel requires about 120 lbs. per ton of steel. The minimum cost of nickel is 2*s.* a lb., and that would give an additional cost over the present plate, which is about 90*l.* a ton, of 12*l.*, irrespective of patent rights. Of course the cost of 12*l.* a ton would not be prohibitive; where 90*l.* is paid for an article, if you get a higher quality article in proportion to the cost, 12*l.* would not be prohibitive.

The CHAIRMAN: What would your steel be compared with that?

Mr. C. W. SMITH: Compared with manufacture of the present armour-plate, there would be no excess in cost; with the direct method of rolling it would be considerably less; a much higher profit could be made on the present price paid. With regard to Sir Charles Craufurd's question about specific gravity, I have not any accurate data. The compound plate, I believe, is about 500 lbs. to the cubic foot. I am sorry I cannot give any further data.

Captain BURGESS: Are you likely to carry out any experiments before long?

Mr. C. W. SMITH: I am not certain, but I am hoping in the course of six months or so that I may be able to have some experiments which I shall have great pleasure, with the permission of the Council, in laying before you.

Captain BURGESS: It would be interesting if you will communicate them to the Journal.

The CHAIRMAN: I am sure I may ask you to present a vote of thanks to the lecturer for his paper. It is more purely scientific, perhaps, than papers of the kind that are commonly discussed in this Institution, and that accounts to some extent for its not being so fully discussed as I venture to think it deserves. I think something might have been said even from our practical point of view on the theory dwelt upon, the gradual absorption of the power of the projectile instead of trying to stop it absolutely, to use its energy in a way which is not destructive to the ship itself. I suppose, practically, the theory is that the element of time comes in, that you exhaust the energy of the shot by occupying the time that you are bringing it to a standstill. While the lecturer was speaking, one began to think what every old cricketer's experience is, that you save your hands by allowing a slight amount of time to operate in bringing the cricket ball to a standstill. I thought the lecturer was perhaps a little hard on the authorities of an ancient historical time, 1875, in their condemnation of steel, because, I think, in the course of his paper he gave us very good reasons to understand that the steel of 1875 is very far indeed from being the steel of 1890. I suppose we might use the familiar expression and say that the one is like chalk and the other is like cheese; we should not be far out. I hope if the lecturer continues his experiments he will let us know the results, because my own impression is that simplicity is always the thing that will last, that any application, such, for instance, as a compound plate, although a necessity in the present state of our knowledge, is almost bound, from the reason of the thing, to give way to something more simple and more homo-

geneous. I think the idea of gradually altering the metal, not by jumping from the hard steel to the soft iron, but by gradually passing from the hard to the soft in one or two successions, does theoretically promise a better result than the present compound plate. I have much pleasure in presenting the thanks of the meeting to our lecturer.

NAMES OF MEMBERS who joined the Institution between the 1st October and the 31st December, 1890.

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Bell, A., Lieut. R.E.
Dugdale, J. B., Capt. Warwick Yeo.
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Haughton, J., Capt. Ben. S.C.
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Winder, R. C., Capt. 9th Lan. Arty. Vols.
Worcester, W. D. G., Lieut. R.N.R.
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Carpenter, G. T., Lieut. Hon. Arty. Compy.
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Versturme, C. H., Lieut. R.E.
Stansfeld, G. M., Surg.-Major 1st V.B. Gloucester Regt.
Stephen, Vincent, Sub.-Lieut. R.N.A. Vols.
Binning, W. W. R., Lieut. 1st V.B. Bord. Regt.
Gamble, R.N., Capt. Linc. Regt.
Campbell, F., Col. 1st Arg. and Bute Arty. Vols. (S. Div. R.A.).
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Washington, Henry H., Capt. R.N. (retd.).
Tomkins, S. Leith, Capt. late 3rd Lan. Fus.
Angove, W. C., Commr. R.N.R.
Dashwood, F. L., Major late 16th Lans.
Houghton, E. R., Lieut. W. Rid. Regt.
Gorges, E. H., Lieut. 16th Ben. Infty.
Gallwey, Sir Ralph P., Bart., late Lieut. Rifle Bde.
Edwards, Robert W., Ch. Eng. R.N.
Richards, W., Lieut. R.N.R.
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Fosbery, G. V., V.C., Col. late Ben. S.C.
Helme, G. C., Col. 4th Middx. Regt.
Vibert, F. W., Lieut. R.N.R.
Clifford, E. T., Lieut. 1st Middx. Eng. Vols.
Dallin, R. J., Capt. late K.'s Drag. Gds.
Campbell, M. S. C., Lieut. R.A.
De Brath, E., Capt. Ben. S.C.
Hepworth, M. W. C., Lieut. R.N.R.
Ranken, A. W., Capt. Sco. Rifles.
Methuen, C. L., Lt.-Col. 1st V.B. Glouc. Regt.

FOREIGN SECTION.

THIS portion of the Number, hitherto the Occasional Notes, has now become the Foreign Section, and is reserved for articles, either original or compiled, on professional subjects connected with Foreign Naval and Military matters; also for notices of Professional Books, either Foreign or English.

The Council of the Institution wish that this section shall be developed still further, and I have undertaken to continue my Editorship during the current year, with a view of aiding them in carrying out this work. It seems to me possible to make this section, and consequently the Journal, the means of keeping our Members acquainted with all naval and military progress abroad *pari passu* with that progress; and I shall be glad to receive from members of both Services, including in the latter those of the Auxiliary Forces, suggestions, information, or offers of assistance.

It is desirable, further, that I should state that, as regards editing the Naval matter in the Section, I shall have the aid of Naval Officers, thoroughly competent to give good advice and to pronounce sound opinions.

It must, however, be borne in mind that, as the change from a quarterly to a monthly issue has been made in order to ensure the more prompt publication of the Lectures after their delivery than has hitherto been the case, the Foreign Section will, as a rule, be restricted in extent during the Lecture season in the first half of the year, and will be prominent in the second half.

It is requested that communications and books for review (the latter under cover to the Librarian) may be addressed to me at the Royal United Service Institution, Whitehall Yard, London, S.W.

LONSDALE HALE,
Colonel ret. R.E.

TACTICAL DEDUCTIONS FROM THE COURSE OF PRACTICE OF THE SWISS FIELD ARTILLERY IN 1890.

By Colonel A. SCHUMACHER, Chief Instructor, Swiss Artillery. Translated by Lieutenant-Colonel WALFORD, R.A.

I. *Practice, Description of Targets, and Results.*

IT may be taken for granted that the Captains who are ordered to attend the course of practice have during the instruction which preceded their appointment fired at least 20 series at the normal targets.

The course of practice would, therefore, if we except the mere change of practice ground, by no means fulfil its object in the case of such Officers as have already practised at Frauenfeld or Bière, if it offered them only the same problems as are connected with elementary practice.

Just as the School of Recruits is the place where ordinary details can be thoroughly and correctly learnt, so the School of Instruction is that where the practice must be adapted to various conditions and problems; for this reason Majors also are ordered to attend the course, in order that they may learn how the higher grades of practice should be carried on. Moreover, at the present moment we are still without certain knowledge as to the value of tactical formations when under artillery fire. The tactical formations of the artillery date also, for the most part, from the days of solid shot, even though we have now in their place shells which give a wide burst, and though there can be no longer any question of the direct hit of a projectile.

While the character of the fire of artillery in former days showed that wide formations were the safest, it would appear as if wide-bursting shell, especially shrapnel, would warn us to avoid broad formations, and to offer only a small front to the fire of artillery.

In accordance with the preceding considerations, the programme for the course was founded on the following principles:—

1. Only the first instructional series should be fired at square wooden targets.[1]

2. For the other series the targets should be such as would be met with on service.[2]

3. As far as possible, all formations which would be used in the tactics of the three arms should be employed as targets.

4. Each practice, advancing from minor to more complicated problems, should represent some phase of battle, and the targets should be arranged accordingly.

5. The duration of the practice and the number of rounds should be gradually increased.

It was further laid down that in all applied practice the distribution of fire should take place at the commencement of group firing, especially against artillery targets, since, on the one hand, the observation of fire at this period in no way demands a fixed and single objective, while, on the other, prudence forbids us to expose ourselves to the fire of such guns of the enemy as are not under our fire. The theory of the successive destruction of the enemy is derived from the days of solid shot; it had still some value when common shell was the principal projectile, but has none now when shrapnel are almost exclusively used.

It must, at the same time, be here mentioned that the utility and possibility of this rule, which have been doubted by some, have been sufficiently proved; it must, at any rate, be accepted that the distribution of fire must be carried out under some, and, when possible, under an invariable, rule.

The whole course of practice consisted of 66 series; of these, Series 1 to 12 were elementary, Series 64 to 66 were for indirect fire, while Series 13 to 63, and more especially 21 to 63, were dedicated to the main question.

The series were as follows:—

1st Series. 20*th March. At Thun.*—Infantry in column of fours (13) are seen; soon after some artillery (14) appears, which is to be silenced; under cover of the fire of the guns, the infantry forms first a column of sections (15), and then proceeds to extend groups and supports (16).

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[1] Owing to an insufficient supply of dummies, they were used for the third and following series only.

[2] Troops in two ranks were invariably represented by a single row of dummies.

Target 13. Column of fours, 40 infantry in fours with 2 paces distance. Range by tangent scale, 2,140 yards. 30 rounds. Time, 11 minutes; interval between rounds, 22 seconds.

14. 3 guns with detachments and teams, limbers at 11 yards interval, following the guns. Range by tangent scale, 1,970 yards. 30 rounds. Time, 12 minutes; interval between rounds, 24 seconds.

15. 2 ranks of 20 files, standing; interval, 10 paces. Range, 2,080 yards. 30 rounds. Time, 12 minutes; interval between rounds, 24 seconds.

16. 4 groups of skirmishers, each of 10 men, kneeling; each group 20 paces wide; 1 man in rear of each group standing; 100 paces in rear of each of the flank groups a support, consisting of 20 men in one rank. Range to the groups, 1,910 yards; to the supports, 2,000 yards. 30 rounds. Time, 12 minutes; interval between rounds, 24 seconds.

2nd Series. 21st March. At Thun.—The enemy's artillery (17) has entrenched itself and must be silenced; in the mean time infantry in column appears (18); some artillery then comes up (19), and is fired on, presumably with success, after which the fire is diverted to the infantry, which has in the mean time extended (20).

17. Emplacements for 3 guns, connected by a shelter-trench; interval between guns, 17 yards; between each two guns is a limber (without its team) in a trench. The parapet is from 10 to 13 feet thick, and its command is, in front of the guns, 18 inches; in front of the limbers, 3 feet. Range, 1,720 yards. 24 rounds. Time, 13 minutes; interval between rounds, 33 seconds.

18. Target as in 15. Range, 1,970 yards. 24 rounds. Time, 18 minutes; interval between rounds, 45 seconds.

19. 4 guns with detachments and teams; limber 11 yards in rear of the guns. Range, 2,080 yards. 24 rounds. Time, 12 minutes; interval between rounds, 30 seconds.

20. Target as in 16. Range to the groups, 1,640 yards; to the supports, 1,750 yards. 24 rounds. Time, 10 minutes; interval between rounds, 25 seconds.

3rd Series. 22nd March. At Thun.—An enemy's battery (21) is to be fired on until an order is received to direct the fire on a company of infantry, which shows itself in column of sections (22). It is found necessary to again fire on the artillery (23), which has in the mean time changed its formation; after this the infantry, which has extended (24), is to be fired on, and finally a column which is advancing on the battery (running target, 25) is to be stopped.

21. 6 guns with detachments; interval, 16 yards; the limbers and teams 11 yards in rear of their guns. Range, 2,190 yards. 24 common shell. Time, 10 minutes; interval between rounds, 25 seconds.

Guns and detachments	188	hits,	41	per cent. of hits.
Limbers and teams.....	273	„	59	„ „
	461		100	

Mean burst of shell, 70 yards short.

22. Four ranks of 20 infantry with 11 paces distance. Range, 2,300 yards. 12 common shell and 18 shrapnel. Time, 11 minutes; interval between rounds, 22 seconds.

1st section	393	hits,	31	per cent. of hits.
2nd section	359	„	29	„ „
3rd section	227	„	18	„ „
4th section	271	„	22	„ „
	1,250		100	

Common shell burst 77 yards short.

Shrapnel 82 to 83 yards short ; 7 to 9 feet above plane.

23. 6 guns with detachments ; 3 limbers in column of route in rear of each flank ; leading limbers 11 yards from the flank guns ; interval of the others, 3·5 yards. Range, 2,130 yards. 24 common shell. Time, 10 minutes ; interval between rounds, 25 seconds.

Guns and detachments	255 hits,	40 per cent. of hits.
Limbers	389 „	60 „ „
	644	100

Mean burst of shell, 68 to 70 yards short.

24. The two rear ranks of target No. 22 were posted 55 yards on the flank of the others ; the range of the two parts of the target differed by about 22 yards. Shortest range, 2,400 yards. 12 common and 18 shrapnel. Time, 9 minutes ; interval between rounds, 18 seconds.

1st section	1 hit,	1 per cent. of hits.
2nd section	9 hits,	7 „ „
3rd section	59 „	44 „ „
4th section	65 „	48 „ „
	134	100

Mean burst of common shell, 80 yards short.

Ditto of shrapnel, 68 yards short ; 10 feet above plane.

25. A moving target, 6 feet high and 16 feet wide, in constant movement on a line slightly oblique to the normal to the front of the battery. Pace, walk. Range, 2,730 to 2,080 yards. 8 common and 16 shrapnel. Time, 10 minutes ; interval between rounds, 25 seconds.

91 hits.

Mean burst of common shell, 80 yards short.

Ditto of shrapnel, 67 yards short ; 19·5 feet above plane.

4th Series. 24th March. At Thun.—Open fire on hostile artillery in emplacements (26). Another battery comes up with its wagons following at 80 yards distance (27). In the mean time infantry have crept towards the battery, and suddenly appear (28). When they have been driven off, a battery in column of route is observed to be approaching the field of battle. The range is found on a conspicuous point, and the column is fired on as soon as it reaches that point (29). Finally infantry, who are visible at a distance in double column (30), are dispersed.

26. Targets as in 17. The guns fire puffs. Range, 1,850 yards. 18 common and 12 shrapnel. Time, 9 minutes ; interval between rounds, 18 seconds.

51 hits.

Mean burst of common, 55 to 57 yards short.

Ditto of shrapnel, 59 yards short ; 10·5 to 18·5 feet above plane.

27. A battery of 6 guns, with detachments and teams, unlimbered ; limbers 11 yards in rear of guns ; 6 wagons 80 yards in rear of the limbers ; teams facing to the rear. Range, 1,530 yards. 12 common and 18 shrapnel. Time, 9 minutes ; interval between rounds, 18 seconds.

Guns.....	118 hits,	42 per cent. of hits.
Limbers	62 „	21 „ „
Wagons	102 „	37 „ „
	282	100

Mean burst of common, 40 yards short.

Ditto of shrapnel, 41 yards short; 12 feet above plane.

28. Four swinging targets[1] 9 yards long, each representing 10 infantry kneeling: in echelon from the front at 11 yards distance. Range, 380 to 440 yards. 12 case shot. Time, 2 minutes; interval between rounds, 10 seconds.

24 hits.

29. A pole marks the point on which the guns are to be ranged; two other poles show the limits within which the target is to be fired on. The target consists of 4 small-arm ammunition carts, at a distance of 8 paces, and pulled forward by means of a wire rope. Range, 1,910 yards. 12 common and 12 shrapnel. Time, 12 minutes; interval between rounds, 30 seconds.

1st wagon	12 hits,	86 per cent. of hits.
2nd wagon	nil	nil
3rd wagon	nil	nil
4th wagon	2 „	14 „ „
	14	100

Mean burst of common, 55 yards short.

Ditto of shrapnel, 60 yards short; 7·5 feet above plane.

30. 320 infantry standing in two parallel columns at 4 paces interval, each column of 8 ranks of 20 men at 10 paces distance. Range, 2,840 yards. 12 common and 12 shrapnel. Time, 12 minutes; interval between rounds, 30 seconds.

Two 1st sections	37 hits,	9 per cent. of hits.
Two 2nd sections	63 „	16 „ „
Two 3rd sections	62 „	15 „ „
Two 4th sections	70 „	17 „ „
Two 5th sections	35 „	9 „ „
Two 6th sections	60 „	15 „ „
Two 7th sections	29 „	7 „ „
Two 8th sections	47 „	12 „ „
	403	100

Mean burst of common, 107 yards short.

Ditto of shrapnel, 107 to 112 yards short; 36 to 68·5 feet above plane.

5th Series. 25th March. At Thun.—Fire is opened on a hostile battery in action (31), of which the wagons stand on either flank at a distance of 330 yards. Under the fire of this battery infantry deploy into a line four deep (32) and open fire; other infantry (33) are advancing in column of fours; the latter are driven back, while the former form line of columns (34) and are broken up; a squadron advancing in column of sections (35) is driven back.

31. Six guns with detachments and teams, unlimbered, the limbers 11 yards in rear of the guns: three wagons on each flank 330 yards in rear of the limbers, in column at 4 paces distance; teams turned to rear. Range to the guns 1,910 yards, to wagons 2,240 yards. 12 common and 18 shrapnel. Time, 11 minutes; interval between rounds, 22 seconds.

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[1] These targets are raised by means of a weight at the foot. When the weight is released by the range-party, the targets appear.—N. L. W.

Guns	121 hits,	26 per cent. of hits.
Limbers	275 „	68 „ „
	396	
Wagons	25 hits,	6 per cent. of hits.
	421	100

Mean burst of common, 55 yards short.

Ditto of shrapnel, 58 to 70 yards short; 16 to 21 feet above plane.

32. 320 dummies, representing a battalion in line, four deep; 1st and 2nd ranks, 160 dummies in line kneeling; 3rd and 4th rank, 160 dummies standing at 1 yard distance; breadth of the target about 145 yards. Small puffs fired in front of the whole of the front rank. Range, 2,190 yards. 12 common and 12 shrapnel. Time, 10 minutes; interval between rounds, 25 seconds.

Front rank	94 hits,	45 per cent. of hits.
Rear rank	116 „	55 „ „
	210	100

Mean burst of common, 68 to 70 yards short.

Ditto, of shrapnel, 72 to 74 yards short; 16 to 23 feet above plane.

33. A company of infantry, 144 men (standing) in column of fours, 36 sections of four men with 2 paces distance; the column is on the edge of a wood, descending a hill; difference of level of the first and last files about 160 feet; slope of the hill, 3 over 4. Range, 2,620 yards. 13 common and 11 shrapnel. Time, 10 minutes; interval between rounds, 25 seconds.

Sections 1 to 9	209 hits,	52 per cent. of hits.
„ 10 to 18	111 „	26 „ „
„ 19 to 27	47 „	11 „ „
„ 28 to 36	50 „	11 „ „
	417	100

Mean burst of common, 96 yards short.

Ditto of shrapnel, 105 yards short, 33 feet above plane.

34. 320 dummies representing infantry standing in 4 columns of sections, each of 4 ranks of 20 men at 10 paces distance; interval between columns 27 yards (half deploying interval). Range, 2,190 yards; 30 shrapnel. Time, 10 minutes; interval between rounds, 20 seconds.

1st rank	343 hits,	29 per cent. of hits.
2nd rank	294 „	25 „ „
3rd rank	255 „	21 „ „
4th rank	302 „	25 „ „
	1,194	100

Mean burst of shrapnel, 77 yards short; 2·5 to 23 feet above plane.

35. 54 cavalry dummies in sections of 18 men, width 20 yards, in 3 ranks at a distance of 20 yards, visible only through the interval between the columns in target 34. Range, 2,620 yards. 30 shrapnel. Time 10 minutes; interval between rounds, 20 seconds.

1st rank	184 hits,	32 per cent. of hits.
2nd rank	179 „	31 „ „
3rd rank	201 „	37 „ „
	564	100

Mean burst of shrapnel, 94 to 96 yards short; 11·5 to 14·5 feet above plane.

6th Series. 26th March. At Thun.—A battery in action (36) is silenced, and the fire is then turned on the wagons, which are supposed to be concealed behind a screen (37). In the mean time infantry deploy first into section-column (38*a*) and then into groups with supports (38*b*); in rear of these is seen a battery advancing in column of sections at full interval (39); this is to be fired on. The practice battery is suddenly charged by cavalry (40); when these have been repulsed, some cavalry which is seen coming up from the back of the practice-ground is fired on (41).

36. 4 guns, made of wood bound with iron, which each fire automatically 8 rounds at intervals of 1 minute. In rear are 4 limbers, teams facing to the rear, at a distance of 11 yards from the guns. Range, 2,080 yards. 30 shrapnel. Time, 8 minutes; interval between rounds, 16 seconds.

Guns and detachments	118 hits,	33 per cent. of hits.
Limbers	240 „	67 „ „
	358	100

Mean burst of shrapnel, 67 to 68 yards short; 14 to 16·5 feet above plane.

37. 110 yards to the rear and 82 yards to the left of the above battery is a wall of earth 22 yards long; in front of this wall is a hedge, made of fir-branches, 33 yards long and about 6 feet high; close in rear of the wall stand the 4 wagons of the battery with 5 yards interval, teams facing to rear. Range, about 2,190 yards. 24 common shell. Time, 8 minutes; interval between rounds, 20 seconds.

142 hits.

Mean burst of common, 69 yards short.

38*a*. Column of sections, 4 ranks of 20 men, standing, with 10 paces distance. Range, 2,130 yards. 24 shrapnel. Time, 10 minutes; interval between rounds, 25 seconds.

38*b*. 4 groups of 10 skirmishers each, kneeling, 110 yards in front of 38*a*; breadth of groups about 16 yards. In the intervals between 1 and 2, and 3 and 4, groups, and partly in rear of them, are two supports, each of 20 men, kneeling; 55 yards in rear of each flank are 20 men, standing. Range, 2,020 yards. 12 shrapnel. Time, 5 minutes; interval between rounds, 25 seconds.

Skirmishers	98 hits,	11 per cent. of hits.
Supports, kneeling	13 „	1 „ „
Supports, standing	159 „	17 „ „
Main body, 1st rank	191 „	20 „ „
„ 2nd rank	153 „	17 „ „
„ 3rd rank	171 „	19 „ „
„ 4th rank	147 „	15 „ „
	932	100

Mean burst of shrapnel, 62 to 68 yards short; 10 to 13 feet above plane.

39. 6 guns with teams, advancing in section column with 16 yards interval

and distance. Total depth of target, 82 yards. Range, 2,080 yards. 2 shrapnel. Time, 9 minutes; interval between rounds, 19 seconds.

1st section	338 hits,	34 per cent. of hits.
2nd section	300 „	33 „ „
3rd section	303 „	33 „ „
	941	100

Mean burst of shrapnel, 68 to 70 yards short; 16 to 18 feet above plane.

40. Three ranks of cavalry, each of 10 files, swinging[1] targets; in echelon, left in front, with 11 yards distance. The battery changes the direction of fire to the left. Range, 330 yards. 1 shrapnel and 12 case. Time, 2 minutes; interval between rounds, 9 seconds.

1st rank	21 hits,	17 per cent. of hits.
2nd rank	81 „	69 „ „
3rd rank	17 „	14 „ „
	119	100

41. Target as in 25 (moving target). Range, 2,190 to 1,640 yards. 12 common and 12 shrapnel. Time, 10 minutes; interval between rounds, 25 seconds.

45 hits.

Mean burst of common, 63 yards short.

Ditto of shrapnel, 50 to 59 yards short; 13 to 16 feet above plane.

7th Series. 27th March. At Thun.—A squadron of cavalry in half column shows itself at the back of the practice ground (42); when these have been driven off, a battalion of infantry in company column is seen more to the front; this is compelled to extend (43). On its left, a battery tries to advance in column of sections (44), but is beaten back as it moves. In the mean time more infantry (45) in column of fours comes down the hill. The hostile battery succeeds in firing a few rounds (46), but is silenced. The infantry has now extended to the right, and is moving against the battery, appearing on the plateau from time to time, as it crosses the ravines, first as a main body (47), then as the front rank of a column of the attack (48), next as skirmishers (49), and, lastly, as rushing in on the battery (50).

42. 54 cavalry dummies in 3 ranks of 18 files, with 20 yards distance, in echelon, left in front. Range, 2,620 yards. 30 shrapnel. Time, 10 minutes; interval between rounds, 20 seconds.

1st rank	119 hits,	32 per cent. of hits.
2nd rank	163 „	44 „ „
3rd rank	89 „	24 „ „
	371	100

Mean burst of shrapnel, 90 yards short; 19·5 feet above plane.

43. 320 standing infantry in four section-columns, each of 4 ranks of 20 men, at 10 paces distance; the two rear columns with an interval of 28 yards; the two front columns (110 yards further to the front) with 110 yards interval. Range, 2,350 yards. 36 shrapnel. Time, 11 minutes; interval between rounds, 18 seconds.

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[1] See Note, page 149.

1st line, 1st rank	4 hits,	1	per cent. of hits.
„ 2nd rank	9 „	2	„ „
„ 3rd rank	21 „	4	„ „
„ 4th rank	9 „	2	„ „
2nd line, 1st rank	69 hits,	11	per cent. of hits.
„ 2nd rank	185 „	31	„ „
„ 3rd rank	122 „	20	„ „
„ 4th rank	149 „	29	„ „
	568	100	

Mean burst of shrapnel, 83 yards short; 15 feet above plane.

44. A battery on the move, in section column; interval, 16 yards; distance between sections, 2 paces; length of column, 55 yards. Range, 2,210 yards. 30 shrapnel. Time, 9 minutes; interval between rounds, 18 seconds.

1st section	278 hits,	30	per cent. of hits.
2nd section	235 „	28	„ „
3rd section	400 „	42	„ „
	913	100	

Mean burst of shrapnel, 74 to 77 yards short; 12 feet above plane.

45. Target as in 33. Range, 2,620 yards. 6 common and 18 shrapnel. Time, 7 minutes; interval between rounds, 17 seconds.

Sections 1 to 10	107 hits,	42	per cent. of hits.
„ 11 to 20	75 „	30	„ „
„ 21 to 30	50 „	20	„ „
„ 31 to 40	21 „	8	„ „
	253	100	

Mean burst of common, 92 yards short.

Ditto of shrapnel, 96 yards short; 27 feet above plane.

46. A battery unlimbered, 6 guns firing. The limbers on the flanks as with target 23. Range, 1,750 yards. 18 common and 12 shrapnel. Time, 10 minutes; interval between rounds, 20 seconds.

Guns	137 hits,	19	per cent. of hits.
Limbers	584 „	81	„ „
	721	100	

Mean burst of common, 48 to 50 yards short.

Ditto shrapnel, 50 to 52 yards short; 8 to 9 feet above plane.

47. Infantry, standing, in section columns, 4 rows of 20 dummies with 10 paces distance; the fire to be directed on one column only. Range, 1,970 yards. 2 common and 18 shrapnel. Time, 6 minutes; interval between rounds, 12 seconds.

1st rank	295 hits,	26	per cent. of hits.
2nd rank	319 „	27	„ „
3rd rank	283 „	25	„ „
4th rank	249 „	22	„ „
	1,146	100	

Mean burst of common, 59 yards short.
Ditto of shrapnel, 63 yards short; 9 feet above plane.

48. 90 files, each of 5 standing infantry, on 4 disappearing targets. Range, 1,530 yards. 12 common and 12 shrapnel. Time, 8 minutes; interval between rounds, 20 seconds.

1st rank..... 108 hits.

Mean burst of common, 41 yards short.
Ditto of shrapnel, 44 yards short; 7 feet above plane.

49. 3 groups of kneeling infantry, each of 10 men, on swinging targets. Range, 1,040 yards. 19 shrapnel. Time, 5 minutes; interval between rounds, 14 seconds.

1st rank..... 124 hits.

Mean burst of shrapnel, 22 to 24 yards short; 8·5 to 9 feet above plane.

50. 4 groups of kneeling infantry, each of 10 men, on swinging targets. Range, 330 yards. 8 shrapnel and 6 case. Time, 1 minute; interval between rounds, 4 seconds.

1st rank..... 79 hits.

8th Series. 28th March. At Gürbenthal.—Fire will be opened on a battery (51*a*) which is advancing; when this has been made to halt, some wagons which are 330 yards in rear of it in a hollow will be attacked (51*b*). In the meantime, infantry (52) come up on the left of the battery; these advance in two echelons (53) and extend in groups (54). The latter advance, being opposed by our skirmishers (dummies with their backs turned to the guns); the enemy, in a crowded formation, divides into a main body (55) and an advanced troop (56), and must be engaged over the heads of our own troops. The enemy's attack is stopped, and while drawing off in column of march, he is fired on at long range (57). The whole of the practice (252 rounds) is to be carried on without intermission.

51*a*. 6 guns, supposed to be moving, the detachments dismounted, the limbers horsed. Range, 3,390 yards. 18 common. Time, 10 minutes; interval between rounds, 33 seconds.

51*b*. 6 horsed wagons, detachments dismounted, teams facing to front 330 yards in rear and 55 yards to the flank of the battery, in a partially covered position, in section column, closed to 4 paces. Range, 3,770 yards. 18 common. Time, 5 minutes; interval between rounds, 16 seconds.

3,390 yards, limbers and teams	12	hits,	46	per cent.	of hits.
Guns and detachments.....	11	„	43	„	„
3,720 yards, 1st section wagons....	1	„	4	„	„
„ 2nd section „	nil		nil		
„ 3rd section „	2	„	7	„	„
	26		100		

Mean burst of common, 40 to 142 yards; 161 to 163 yards short.

52. 40 standing infantry, 2 ranks of 20 men, at 10 paces distance. Range, 3,600 yards. 24 common. Time, 7 minutes; interval between rounds, 18 seconds.

1st rank	6	hits,	46	per cent.	of hits.
2nd rank.....	7	„	54	„	„
	13		100		

Mean burst of common, 155 yards short.

53. Two lines each of 20 standing men, distance 135 yards. Interval, 55 yards. Range, 3,390 yards. 36 shrapnel. Time, 14 minutes; interval between rounds, 23 seconds.

1st line ..... 111 hits; no hits on 2nd line.

Mean burst of shrapnel, 145 to 147 yards short; 32 feet, 20·5 feet, and 12·5 feet above plane.

54. 4 groups of 10 skirmishers kneeling, each group about 16 paces wide, half covered behind the bank of a road. Range, 3,170 yards. 36 shrapnel Time, 19 minutes; interval between rounds, 32 seconds.

56 hits.

Mean burst of shrapnel, 127 to 129 yards short; 29 to 35 feet above plane.

55. 40 infantry, 2 ranks of 20 men, with 10 paces distance; the rear rank standing, the front kneeling. Range, 3,060 yards. 48 shrapnel. Time, 8 minutes; interval between rounds, 10 seconds.

1st rank, kneeling.....	11 hits,	12 per cent. of hits.
2nd rank, standing	80 „	88 „ „
	91	100

Mean burst of shrapnel, 118 yards short; 23 feet above plane.

56. 6 groups of 10 files of kneeling infantry, about 330 yards in front of target No. 55; between 55 and 56, in rear of the 2nd and 5th group, are supports of 20 men each, standing in line; our own troops are 275 yards nearer to the guns. Range, 2,620 yards. 48 shrapnel. Time, 20 minutes; interval between rounds, 25 seconds.

1st rank, skirmishers	51 hits,	35 per cent. of hits.
2nd rank, supports	93 „	65 „ „
	144	100

Mean burst of shrapnel, 90 to 99 yards short; 15·5 to 20 feet above plane.

57. Infantry in column of sections, 80 men in 4 ranks of 20, with 10 paces distance. Range, 4,040 yards. 24 common. Time, 10 minutes; interval between rounds, 25 seconds.

1st rank, 2 lines	2 hits,	50 per cent. of hits.
2nd rank	1 hit,	25 „ „
3rd rank	1 „	25 „ „
4th rank	nil	
	4	100

Mean burst of common, 189 to 211 yards short.

Time for the whole 252 rounds, 95 minutes; average interval between rounds, 22·6 seconds.

9th Series. 28*th March. At Gürbenthal.*—An enemy's battery opens fire, and is answered (58*a*); after supposed success the limbers, which are on the flank of the hostile battery, are attacked (58*b*). Infantry advance in front of the battery; they have extended from company column, and represent the reserve; fire is opened in succession on the reserve (59), the supports (60), and the firing line (61). When this attack has been repulsed, the enemy tries to hold a position farther to the rear (62), but is dislodged. Cavalry

come up in the background, but are driven back. The whole series fired consecutively.

58*a*. 6 guns in position with detachments, marked by puffs. Range, 2,900 yards. 24 common and 24 shrapnel. Time, 27 minutes; interval between rounds, 34 seconds.

58*b*. The limbers of the battery, about 110 yards to the rear, and 66 yards to a flank, in columns of sections, close intervals, teams facing the rear. Range, 3,060 yards. 18 shrapnel. Time, 10 minutes; intervals between rounds, 33 seconds.

2,900 yards, guns and detachments....	70	hits,	40 per cent. of hits.
3,060 „ limbers	120	„	60 „ „
	190		100

2,900. Mean burst of common, 122 to 124 yards short.

Ditto of shrapnel, 124 to 156 yards short; 27 feet above plane.

3,060. Mean burst of shrapnel, 136 short; 12 feet above plane.

59. Two columns of sections, 80 men in 4 ranks of 20, with 10 paces distance. Range, 2,020 yards. 18 common and 24 shrapnel. Time, 8 minutes; interval between rounds, 11 seconds.

1st ranks	245	hits,	27 per cent. of hits.
2nd ranks	170	„	18 „ „
3rd ranks.....	235	„	25 „ „
4th ranks.....	275	„	30 „ „
	925		100

Mean burst of common, 61 to 63 yards short.

Ditto of shrapnel, 66 to 68 yards short; 21 to 28 feet above plane.

60. 2 squads 220 yards further to the front, each of 40 men, in 2 ranks, with 10 paces distance, kneeling, with intervals of 176 yards. Range, 1,800 yards. 24 shrapnel. Time, 6 minutes; interval between rounds, 15 seconds.

1st rank	144	hits,	54 per cent. of hits.
2nd rank	124	„	46 „ „
	268		100

Mean burst of shrapnel, 55 to 55 yards short; 9 to 15 feet above plane.

61. A thick firing line of 6 groups of 10 men kneeling, with 4 groups of 10 men kneeling covering the outer intervals. Range, 1,640 yards. 24 shrapnel. Time, 5 minutes; interval between rounds, 13 seconds.

Front groups	60	hits,	62 per cent. of hits.
Rear groups.....	37	„	38 „ „
	97		100

Mean burst of shrapnel, 45 yards short; 13 feet above plane.

62. 6 groups of kneeling infantry, each of 10 men; width of a group about 16 paces, that of the whole line about 110 yards. Front irregular. Range, 2,300 yards. 12 common and 32 shrapnel. Time, 13 minutes; interval between rounds, 17 seconds.

163 hits.

Mean burst of common, 70 to 72 yards short.

Ditto of shrapnel, 70 to 72 yards short, 21 feet above plane.

63. 36 cavalry (2 sections) in 2 ranks of 18 men, with 20 yards distance. Range, 4,150 yards. 13 common and 6 shrapnel. Time, 5 minutes; interval between rounds, 16 seconds.

1st rank	6	hits,	30	per cent. of hits.
2nd rank.....	14	„	70	„ „
	20		100	

Mean burst of common, 187 yards short.

Ditto of shrapnel, 187 yards short : 46 feet above plane.

Time for the whole series (219 rounds) 80 minutes; average interval between rounds 22 seconds.

The record of the effect on the various targets gives the above results, in which the effects of shrapnel and of ring-shell are taken together; for the further deductions which it is proposed to draw, the effect which was the consequence of the united action of shells and shrapnel will be merely taken as caused by so many rounds. Materials are available which would render it possible to distinguish the separate effect of each projectile, but to do so would entail endless labour, without making any important alteration in the amount or value of the information to be obtained.

II. *Comparisons and Conclusions.*

Even a cursory glance at the results of this practice gives the impression that the effect of the wide-bursting projectiles of artillery increases with the depth of the target, and only partially with the width ; it is worth while to go a little more into this question.

The foregoing results are certainly the first which we have obtained, while a satisfactory conclusion can be derived only from a series of trials with similar factors ; it is, therefore, not merely a matter of interest, but one of duty, to repeat and complete such practice ; but to do this would need a great expenditure of ammunition, and this must be spread over several years and courses. An immediate and approximate judgment is, however, desirable, and it is possible to make a comparison of the results if we use a process which is perhaps rather arbitrary.

In order to compare the question of formations, similar bodies of troops must be taken together, and in combination with the three factors : number of rounds, range, and size of the target or of the number of targets.

The first factor may be arrived at with sufficient accuracy, if the six first rounds be deducted from each series, and if the number of hits be divided by the remaining number of rounds, which will give the number of hits for each effective round ; this proportional number should then, for each series or formation, be multiplied by some common number of rounds, say 72.

This corrected number of hits must then be fairly adjusted as regards the range ; a correct computation must have for its basis the length of the dangerous zone which corresponds with the particular size and range of the target. Since, however, an approximate comparison only is possible, it will be sufficient to take account of the most important factor—the angle of descent—and to multiply the corrected number of hits by the tangent of this angle. A comparison of the actual number of hits with the same when corrected by the angle of descent will enable us to judge whether this mode of proceeding may lead us to expect to thus make an approximate estimate of value.[1]

[1] It may perhaps be well to explain the system pursued in the following tables a little more fully.

We must, finally, endeavour to assimilate the targets by means of a factor, which shall in a simple manner correct their several ratios; thus a fire which is directed on 4 guns can be compared with one carried out on 6 by multiplying the number of hits by 1·5.

With respect to infantry, the following points may be deduced:—

1. The best formation for a battalion.
2. The best formation for a company.
3. The thickness of men in the firing line.
4. A comparison between standing and kneeling targets.

Owing to the insufficiency of the amount of practice, we have not sufficient data for the cavalry; at the most we can only compare the column of sections and the half column.

With regard to the artillery, we may learn—

1. The proper position for the wagons.
2. That for the limbers.
3. The effect of column formations.
4. What is the risk of movement within range of the enemy.

It is not the object of this paper to bring to notice every point which might be of value, since for this we must first obtain further information; it is merely as it were a provisional sign-post, pointing out in which direction we should seek for further experience, and make a further comparison: the present work is only the first effort and the first contribution towards the solution of this important question.

If we compare the results given above, we shall arrive at the following data:—

a. *Against Infantry Targets.*—1. The formations of the battalion (320 dummies) are as follows:—

30. A battalion in double column.
32. A battalion in line four deep.
34. A battalion in line of columns.
43. A battalion in company columns.
55 and 56. A battalion in the act of extending.
59 to 61. A battalion extended.

The first column gives the number of the practice which is to be considered,

The second column gives the number of rounds actually fired in that practice.

The third number shows this number minus six rounds deducted as ranging rounds.

The fourth column gives the total number of hits obtained in the practice.

The fifth column shows the quotient of the fourth column divided by the third, giving average of hits for each round.

The sixth column is the fifth column multiplied by 72, showing the hits which would have been made had 72 rounds been fired at each target.

The seventh column gives the range in yards for each practice, and the eighth the tangent of the consequent angle of descent multiplied by 1,000.

The ninth column shows the product of the sixth multiplied by the eighth.

It is considered that the varying conditions of the several practices are thus reduced to a common standard for the purpose of comparison.—N. L. W.

TABLE I.

No. of target.	No. of rounds.	Effective rounds.	Hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent.[1]	Ratio.	
30	24	18	404	22·4	1,616	2,840	149	240,784	
32	24	18	210	11·7	840	2,190	98	28,320	
34	30	24	1,194	49·7	3,582	2,190	98	351,036	
43	36	30	568	18·9	1,136	2,350	109	123,824	
55	48	42	91	2·1	151	3,060	168	23,668	55,763
56	48	42	144	3·4	245	2,620	131	32,095	
59	42	36	925	25·7	925	2,020	86	79,550	
60	24	18	268	14·9	268	1,800	72	19,290	104,951
61	24	18	97	5·4	97	1,640	63	6,111	

[1] The natural tangent of the angle of descent ×1,000.—N. L. W.

Thus the effect stands in the following order :—

1. 34. Battalion in line of columns.
2. 30. Battalion in double column.
3. 43. Battalion in company column.
4. 59 to 61. Battalion extended.
5. 32. Battalion in line four deep.
6. 55 and 56. Battalion in act of extending.

If the range be taken as the factor in place of the angle of descent, the table of effect will stand exactly in the same order.

The above table shows at once that the most crowded targets are the most dangerous. The fact that the line of columns receives more hits than the double column can be explained by the circumstance that with the former the fronts of all four columns are at the same distance, and that it is thus easy to carry out the distribution of fire, while the target is deep enough to catch all shell that are too high to hit the front rank, which is the true target.

A double column is twice as wide as a section column, and it is very improbable that many shell will fall to the right or left of it; if it shows fewer hits than a line of columns at half deploying interval, this is due to the fact that the guns are laid on the front rank, and that normal rounds produce an effect only as far as the third or fourth rank; only a few shell, which fly too high, will strike the rearmost ranks.

It would seem as if greater effect should be obtained on the double column; but to do this would entail a change in elevation. Such a proceeding, however, can be used for fixed targets only, and we are thus brought to the conclusion that a battalion which, when within sight of the enemy, advances in line of columns runs more risk than if it were formed in double column. Target No. 43 shows what a difference it makes if all parts of the target are at the same distance from the guns. For it is rarely possible to decide from the battery as to which are the leading companies, unless all four companies can be observed directly from the front, and it can thus be determined that the flank companies are the foremost; as a rule, those which stand highest are taken to be the foremost, and *vice versâ*. This circumstance makes the distribution of fire exceedingly difficult, especially when all four companies are also in movement. It thus seems that an advance in company columns is advantageous, when the enemy's artillery does not occupy a higher level than our infantry; but we further learn, from target No. 32, that another formation, the line four deep, is yet more advantageous.

The fact that the effect on the line four deep stands in the table between the results obtained on the extended formations of the battalion is not solely to be ascribed to the particular practice (though the burst of the shell was too short, 176 to 187 yards short), since the target stood exposed on good even ground, on which the breadth of the burst must have been advantageous, and on which even ricochet hits might be expected. It arises rather from the small depth of the target; this is clearly shown in Targets 59 to 61, where the percentage of hits increases not with the number, but with the closeness of the targets, that is to say, with the depth of target. If we remember that a line of two or four ranks will not suffer at all from such shell as pass over it, while, on the other hand, troops when extended according to regulation, will find that such shell as are too high to hit the foremost rank will strike the supports or the reserve, it becomes a very serious question whether infantry, who are within reach of hostile artillery fire, may not be best formed for the advance, either with the battalion in four closed ranks, or as a line of companies two deep. It is also a matter for consideration whether the advantage of easily

finding cover is of such great importance, that with this object the desirability of the mutual support and the close connection of the lines can be disregarded. With extended and, as is the case in practice, close and strong lines of skirmishers, experience teaches us that the use of small cover afforded by the ground is often neglected ; deep well-marked cover is always taken advantage of ; the lines are sure to get crowded there, and often to such an extent that we find them in four or more ranks, but in no sort of order. If we take account of the effect of infantry fire on such formations, we may theorize on the advisability of the adoption of a formation compounded of that of Frederick the Great with that of Napoleon, including the occupation of the front with thin lines of skirmishers, the advance of the reserves under artillery fire in two or four closed ranks, an extension into two ranks when within the zone of infantry fire, the skirmishers being absorbed (on the flanks, as is now the case), and, finally, the assault on a serried line.

In comparison with the effect against a whole battalion, let us take those against a single company.

2. The formations of a company are as follows :—
22. Column of sections.
24. Column of sections, broken up.
33. Column of files.
45. Do. do.
47. Column of sections.
55 and 56. Company extended.
57. Column of sections (at a long range).
60. Two subdivisions in column of sections.
61. Company in groups.

TABLE II.

No. of target.	No. of rounds.	Effective rounds.	No. of hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent.[1]	Ratio.	
22	30	24	1,250	52·1	3,750	2,300	106	397,500	
24	30	24	134	5·6	402	2,400	114	45,828	
33	24	18	417	23·1	1,668	2,620	131	218,508	
45	24	18	253	14·0	1,012	2,620	131	132,572	
47	30	24	1,146	47·7	3,438	1,970	83	285,354	
55	48	42	91	2·1	151	3,060	168	23,668	55,763
56	48	42	144	3·4	245	2,620	131	32,095	
57	24	18	4	0·2	16	4,040	262	4,192	
60	24	18	268	14·9	1,072	1,800	72	77,084	
61	24	18	97	5·4	388	1,640	63	24,444	

[1] The natural tangent of the angle × 1,000.—N. L. W.

Thus the effect stands in the following order :—

1. 22. Column of sections.
2. 47. Do. do.
3. 33. Column of fours.
4. 45. Do. do.
5. 60. Two subdivisions in column of sections.
6. 55 and 56. Company extended.
7. 24. Column of sections, broken up.
8. 61. Company in groups.
9. 57. Column of sections (at a long range).

Target No. 57 may be struck out of the foregoing table, on account of the long range and the fact that common shell only were used, since these projectiles struck the soft ground at a high angle and buried themselves.

After the comparison which has already been made, it is not surprising to find that the column of sections of the entire company is the most unfavourable for safety ; following the theory of the effect of the depth of a column, the column of fours holds with a company almost the same position as does the double column in the case of a battalion ; it is indeed closer, but on the other hand it is smaller. It must also be observed that in the instances quoted the columns of fours did not move directly against the battery which was firing on them, while they were, moreover, at a varying distance from it. Many shell must also have fallen to one side of them, many must have been short, while there were, so to speak, no ricochet hits ; both results warn us again against a deep formation.

The results against the four other company targets, viz., that in subdivisions (each being in column of sections) and those when fully extended, give very nearly the same effect. Even when the difference of range of one half of the company is so insignificant, as was the case with Target No. 24, it is obvious how difficult it is to distribute the fire ; the fact that No. 24 target showed less effect than the widely divided Target No. 60 is accounted for by the more easy observation of fire which was possible with the latter, owing to the higher station of the battery when firing at it : under similar circumstances Target No. 24 must have received more hits than Target No. 60.

If then targets divided into two parts, with small intervals and distances between those parts (each of these consisting of two ranks at ten paces distance), are not more unfavourable to safety than a complete extension, nothing prevents our arriving at the conclusion that the advance of a company under artillery fire in two subdivisions in column of sections (which are less than a musket-shot apart), while it has great advantages as regards the conduct of masses of troops, is not more dangerous with respect to the effect of fire than would be the case with the normal extension into groups and supports, or into groups and reserve. There is no doubt that even this effect can be still more diminished if the rear sections open out while advancing, or if the two sections, each four deep, place themselves side by side, while this latter formation gives an even smaller depth.

The difference between the results on Targets Nos. 60 and 61, which were fired at under very similar conditions, compels us to make some reference to the effect of the close nature of the target ; in doing this we must take into account the number of men in the skirmishing line.

3. Closeness of kneeling skirmisher lines.

38.	6	groups,	60	kneeling	men,	factor	1·66
54.	4	„	40	„	„	„	2·50
56.	6	„	60	„	„	„	1·66
61.	10	„	100	„	„	„	1·00

To compare effect on a company of 100 men.

TABLE III.

No. of target.	No. of rounds.	Effective rounds.	No. of hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent.[1]	Factor.[2]	Ratio.
38	36	30	98	3·2	235	2,020	86	1·66	33,548
54	36	30	56	1·8	132	3,170	178	2·50	68,740
56	48	42	51	1·2	87	2,620	131	1·66	18,919
61	24	18	97	5·4	388	1,640	63	1·00	24,444

[1] The natural tangent of the angle ×1,000.—N. L. W.
[2] Proportion of company of 100 men to the number of dummies.—N. L. W.

Thus the effect stands in the following order :—

1. 54. 4 groups kneeling.
2. 38. 6 „ „
3. 61. 10 „ „
4. 56. 6 „ „

One would have thought that the number of hits would have been considerably increased, when a larger number of men stood on the same space ; and in a certain sense this must be true. But against this supposition is the fact that it is easier to distribute the fire over a broken line of groups than when the whole of the visible target shows as a complete line.

The above unexpected results show that a thickening of the lines of skirmishers on a given front, or a closer concentration of them towards one spot, does not expose them to any greatly increased danger from artillery fire ; in any case that danger is not, under any circumstances, subject to such an increase as would be given by a deep formation. This statement assumes, however, that the height of the target is not such as to give the effect of depth. The following figures show what a difference the height of the target will make :—Targets Nos. 32 and 55 have each a front rank kneeling and a rear rank standing ; the percentage of hits on the kneeling are 45 and 12, while those on the standing are 55 and 88. Taking the mean, we find that under an equal fire the kneeling line will receive three-tenths of the hits, and the standing seven-tenths ; in other words, the effect on the standing is more than double that on the kneeling line. This comparison further informs us that the effect of bursting shell is but little increased by the breadth or the closeness of the target, but that the height or the corresponding depth are the real factors which increase effect, and which must be considered when selecting tactical formations to be used under artillery fire.

b. *Against Cavalry Targets.*—The limited practice against cavalry gives the following results :—

4. The formations of cavalry were as follows :—

35. Column of sections,	54 files ;	prop.,	9·6 ;	factor,	1·0	To compare with a squadron of 54 files.
40. Half column, ditto,	30 do. ;	do.	5·6 ;	do.	1·8	
42. Ditto, ditto,	54 do. ;	do.	9·6 ;	do.	1·0	
63. Column of sections,	36 do. ;	do.	6·6 ;	do.	1·5	

TABLE IV.

No. of target.	No. of rounds.	Effective rounds.	Hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent.[1]	Factor.[2]	Ratio.
35	30	24	564	27·7	1,692	2,620	131	1·0	221,652
40	13	13	119	9·1	655	330	6	1·8	3,834
42	30	24	371	15·4	1,133	2,620	131	1·0	148,423
63	19	13	20	1·5	108	4,150	273	1·5	44,226

[1] The natural tangent of the angle × 1,000.—N. L. W.
[2] Proportion of a squadron of 54 files to the actual number of dummies.—N. L. W.

Thus the effect stands in the following order :—

1. 35. Column of sections.
2. 42. Half-column.
3. 63. Column of sections.
4. 40. Half-column (at 320 yards with case).

Of these only 35 and 42 are of use to enable us to form an opinion ; the depth of both targets is the same, but the half-column of target 42 becomes less close as the width increases ; thus the results must be nearly the same. This would not be the case with a squadron in line, if such a comparison could be made ; from what we have already learnt, we may conclude that in this latter formation the risk of loss under artillery fire, especially on the move, would be very small, probably even less than would be the case if the same front were covered by an attack in swarms, since this would imply a greater number of targets in depth.

This opinion is strengthened by the effect on Target 40, where the second (that is to say, the centre) rank shows the greatest number of hits by case. This description of projectile, when used against broad fronts and at a short range, gives the best distributed, and, therefore, the greatest, effect ; the difficulty is for the artillery to give proper attention to the distribution of fire at moments of intense excitement ; if this could be done, it might be possible to use also shrapnel with the time fuze carefully set ; with regard to the last period of the charge, the effect will depend mainly upon one thing, viz., whether the line of charging cavalry is in open or close order ; but even in this case the depth of the formation will act prejudicially.

c. *Against Artillery Targets.*—The third group of records concerns fire against artillery targets, composed of either the whole battery or of the guns and limbers only. In order to compare 4-gun batteries with 6-gun, the hits on the former must be multiplied by 1·5.

5. The formations of artillery are as follows :—

The whole battery.

27. With wagons at 80 yards distance.

31. With wagons at 330 yards distance, on either flank.

36 and 37. With wagons under cover (4 guns and 4 wagons).

51*a* and 51*b*. 6 guns unlimbered, 6 wagons in column of sections, 360 yards to the left rear of the guns.

TABLE V.

No. of target.	No. of rounds.	Effective rounds.	No. of hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent.[1]	Factor.[2]	Ratio.	
27	30	24	282	11·7	846	1,530	57	..	48,222	
31	30	24	421	17·5	1,263	1,910	79	..	99,777	
36	30	24	358	14·9	1,074	2,080	90	1·5	144,990	224,226
37	24	18	142	8·0	568	2,190	93	1·5	79,236	
51*a*	18	12	23	1·9	138	3,390	198	..	27,324	31,536
51*b*	18	12	3	0·2	18	3,770	234	..	4,212	

[1] The natural tangent of the angle × 1,000.—N. L. W.
[2] The proportion of 6 guns to the number actually fired on.—N. L. W.

Thus the effect stands in the following order :—

1. 36 and 37. Wagons under cover.
2. 31. Wagons at 330 yards distance, on either flank.
3. 27. Wagons at 80 yards distance.
4. 51*a* and 51*b*. Guns in action, wagons in column of sections 360 yards to the left rear.

The above can be compared with the following percentages of effect on the whole battery :—

No. of target.	Guns and detachments.	Limbers and teams.	Wagons and teams.
27	42	21	37
31	26	68	6
36 and 37	29	48	23
51*a* and 51*b*	46	43	11

Thus Target No. 31 suffered the least, having its wagons on the flanks 330 yards in rear of the limbers, though 6 rounds out of 30 were specially directed on the former. But the distance of burst was about 220 yards in front of the wagons, which brings us to the statement which has already been made, that shrapnel shell has no effect beyond a fixed depth; in this case the rear dummies were about 269 yards from the point of burst, which was only about 19 feet above plane. The greatest proportional effect was on Target No. 27, when no special fire was delivered on the wagons, and when the burst of the shell was 220 yards in front of the guns, and thus nearly 300 yards from the rearmost dummies. The strikingly contradictory results given by these two examples can only be explained by the fact that with Target No. 27 the bullets could ricochet as far as the wagons, which with Target No. 31 was not the case; thus with Target No. 27 the number of hits was greater, and the effect of each bullet less, while with Target No. 31 only direct hits were counted.

In the first table the Target Nos. 36 and 37 is at the head of the list; the reason for this is, that the wagons received 23 per cent. of the hits, although they stood behind a covering mass and a screen, though certainly close up to the latter and very near together. The lesson to be learnt from this is again not new, viz., that cover does not shelter deep targets which are on the same level, and that screens are only of value when the object to be hidden stands far in rear of them. The above experience shows us that the distance between them should be at least 320 yards.

When the wagons were placed in line 80 yards in rear of the front of the guns, they received too many accidental hits; even 320 yards distance did not prevent this; a separate position, as in Target No. 51*b*, is evidently equally dangerous as one in rear of the battery, if it implies a considerable depth. The best formation is to place the wagons parallel to the line of the battery, and in column of route, taking care that they are as far as possible concealed from view; unquestionably the most dangerous screens are such as can be clearly seen, and these again become worse as they are nearer to the battery.

If both the above tables be taken into consideration, the order of the targets, as regards danger, is as follows :—

Nos. 37, 27, 31, 51*b*.

6. Battery without wagons.

The following formations were tested :—

21. 6 guns and limbers, teams facing the rear.
23. Ditto, limbers on the flanks.
27. Ditto, limber teams unhooked (wagons not counted).
31. Ditto, normal formation.
36. 4 guns, ditto, ditto.
39. 6 guns, in column of sections at full interval.
44. Ditto, column of sections at half interval.
46. Ditto, with 3 limbers on each flank.
51*a*. Limbers in front of guns, teams hooked in.
58*a* and 58*b*. 6 guns, limbers in column of sections, in flank and rear of the guns.

TABLE VI.

No. of target.	No. of rounds.	Effective rounds.	No. of hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent.[1]	Factor.[2]	Ratio.	
21	24	18	461	25·6	1844	2190	98	..	180,712	
23	24	18	644	35·7	2576	2130	93	..	239,568	
27	30	24	180	7·5	570	1530	57	..	32,490	
31	30	24	396	16·5	1188	1910	79	..	93,852	
36	30	24	358	14·9	1074	2080	90	1·5	144,990	
39	29	23	991	43·1	3102	2080	90	..	279,180	
44	30	24	918	38·2	2754	2210	99	..	272,646	
46	30	24	721	30·0	2163	1750	69	..	149,247	
51*a*	36	30	23	0·8	55	3390	198	..	10,890	
58*a*	48	42	70	1·7	122	2900	153	..	18,666	154,026
58*b*	18	12	120	10·0	720	3060	188	..	135,360	

[1] The natural tangent of the angle × 1,000.—N. L. W.
[2] Proportion of 6 guns to the number actually fired on.—N. L. W.

Thus the effect stands in the following order :—

1. 39. Column of sections, full interval.
2. 44. Column of sections, half interval.
3. 23. Battery with limbers on the flanks.
4. 21. Battery with limbers and teams, normal.
5. 58*a* and 58*b*. Limbers in column of sections, in flank and rear of the guns.
6. 46. As with Target No. 23.
7. 36. Normal formation.
8. 31. Normal formation.
9. 27. Normal formation.
10. 51*a*. With horsed guns.

This comparison gives more certain results than that with the wagons. If we compare the three formations fired at, we find, as we did before, that the line at full interval is the safest and the best formation for movement. The two columns of sections prove themselves to be very dangerous formations, and, since both were fired on under the same conditions, that at full interval was more dangerous than that at half-interval. The apparent contradiction which may be observed, is explained, if we remember the double column of infantry as compared with the line of columns, while not forgetting that the columns of sections of artillery are half as high again as those of the infantry (9 feet to 6 feet), and if we recollect what a great difference the height of the target made in the comparison between the effect on kneeling and standing lines. In the case of the column of sections at full interval even the very highest bullets of the cone of burst are not lost, as they may well be in the case of a close column. The columns of sections are really bullet-traps.

With regard to the position for the limbers, we have here more information, for, with the exception of series No. 58*b*, the limbers were not specially fired at; since Target No. 21 comes between Targets Nos. 23 and 46 (where the limbers were on the flanks), we may see that the normal position, 11 yards in rear of each gun, is not so dangerous as an uncovered position showing depth. If we take the percentage for each practice, we find :—

No. of target.	Limbers.	Guns.	Limbers.
21	Normal	41	59
27	do.	65	35
31	do.	30	70
36	do.	33	67
23	massed	40	60
46	do.	19	81
58	do.	40	60
Mean of the 4 first.....		42	58
Mean of 3 last		33	67

Thus the limbers will be better posted in rear of the guns, giving a small depth, than in long columns on the flanks.

It is worthy of notice that the limbers receive from three-fifths to two-thirds of the hits, a circumstance which can only be ascribed to the large target offered by the teams; this may be observed also with Target No. 51*a*, where the limbers, which were then in front of the guns, received 52 and the guns only 48 per cent. of the hits; it is therefore certain that, given the present shell and the present formations, the horses will be killed

before the gunners, and that after the first few rounds the mobility of the battery will be at an end, unless it be accepted as a principle to govern all tactical formations, that the limbers shall be separated altogether from the guns, or at least that the teams shall be unhooked. Target No. 585 shows that they are by no means safer when they are massed outside of the battery, and still remain visible; even in this case the wisest thing to do would be to place the limbers or their teams under cover, or at some distance in rear of screens; they must not, however, when in rear of cover, be posted so as to offer a deep target, but must be on a broad front, either in line with large intervals (11 yards), or in column of route along the line of cover; when behind mere screens they must be at least 320 yards from them, if it be in any way possible to obtain so much distance.

If we endeavour to express the results obtained on the moving targets in terms of those obtained on standing targets, we may assume that the effective fronts of the latter are, taking the moving target as unity, as follows:—

The front of a section of infantry—2.

The front of a section of cavalry—4 or at least 3·5.

It must be further remembered that the moving target represents only the front rank. If we take the stationary Target No. 60 for comparison, we find that the front rank received 144 hits, while the same front with Targets Nos. 25 and 41 (moving targets) received 142 hits, and thus very nearly the same number; there would be the same proportion of hits on the second rank; if we increase the pace a little and allow the infantry to pass over the same space in four-fifths of the time, the number of hits will be diminished by one-fifth only.

Passing on to the cavalry we may take fire on a column of sections in movement to be represented by Target No. 35.

	1st rank.	2nd rank.	3rd rank.	Total.
Standing target, 30 rounds	184	179	201	564
Ditto, 24 rounds	138	135	150	428
Moving target	71	(69	77	217)[1]
Ditto, per section, ratio 3.....	213	207	231	651
In movement, walk, three-fourths of time	160	155	194	489
Trot, one-fifth of the time	43	41	46	130

Target No. 29 is of great interest; the moving carriages could be fired on for a space of 185 yards; the battery was ranged on the centre of this space; the time required for a column of 6 carriages to pass it was:—

The centre space at a walk	60 seconds.
„ at a trot	22 „
The whole space at a walk	2 min. 53 secs.
„ at a trot	1 min. 5 secs.

The length of column was two-fifths of a column of 6 guns.

[1] The numbers within brackets are estimated on the ratio of the 1st column, viz.: 71 to 138.—N. L. W.

The hits received in 30 seconds were 14; this gives for 6 guns at a walk 35 hits, at a trot 13 hits.

It follows that a space of about 220 yards can be passed by the flank march of a battery at a walk without any considerable risk, even when the enemy's battery is ranged; but it must be possible for the rear carriages to be able to pass any carriage which may break down; at a trot there is very little risk. If the space where the column is visible to the enemy is very short, the danger is still more reduced; for example, if it be only 18 yards, there will be but 3·5 hits at a walk and 1·3 at a trot. The lesson taught by the other targets was also true of this, viz., that not the length, but the depth in the direction of the line of fire, of any formation is a measure of its risky character.

It remains to make a few observations which may be of value with regard to the conduct of fire.

The "rate of fire" is always slower against artillery targets, since the laying must be more exact; the greatest rapidity was 16 seconds between rounds, the least, owing to bad light and long range, 34 seconds; mean, 23 seconds. Cavalry is easier to see even at long ranges; the rate of fire was from 16 to 20; mean, 19 seconds between rounds. Infantry, when near, is easier to lay on than cavalry, but at a distance somewhat more difficult on account of its smaller height; rate from 11 to 32, mean 20 seconds.

At long-continued practice it is found that as a mean, even when the brakes were used, the average pace did not exceed 22·3 seconds between rounds; the limits were from 11 to 34 seconds between rounds. After 30 successive rounds from each gun the detachment begin to tire; after 40 rounds there must be a pause; fire should not be kept up for more than 90 minutes at this rate since the consequent fatigue very much diminishes the trustworthiness of the detachment. When the guns have no brakes two hours must be allowed for 40 rounds, or even sometimes for 30; otherwise the detachment will tire very soon and the service of the gun will deteriorate.

The greatest pace for rapid fire, if the guns are to be fired more than once, is 4 seconds between rounds; as a rule, the last round will have an interval of 2 seconds; a whole series of 24 to 30 rounds will have a mean of from 10 to 15 seconds instead of from 18 to 25 seconds between rounds. Setting the fuzes of shrapnel beforehand accelerates only the first round, and this very little, since of all the processes included in loading the setting of the fuze is that which takes up the least time.

With regard to the behaviour of the guns, only two disadvantages show themselves after continued firing. One is, that by opening and closing the breech-wedge a certain amount of powder residue is always collected, which lies at one point of the lands (about 25 degrees right of under); this point must therefore be always looked after, though this can be done only when one screw is loosened and the breech-block withdrawn. On this account, and in order not to injure the gun, not more than 20 consecutive rounds ought to be fired without cleaning the gun; any convenient moment may be utilized for this purpose.

If this be neglected the gun does not indeed become unserviceable, for it can fire 80 rounds or, if necessary, even more; the only consequence will be that the ring and the surface of the bore will be so scored that they will have to be faced. With smokeless powder there is no such defect.

The other disadvantage concerns the lever of the elevating gear, which is crushed by the recoil at the spot where the outer ring grasps it, with the result that a regular ring of disintegrated wood about 1 centimetre thick is formed on it; finally the sound part of the lever becomes too weak and breaks at this particular place. Fractures at other points are rare, and are to be attributed to bad workmanship when making the lever.

When the brakes are used the point of the trail buries itself less in wet ground than is the case when there are no brakes; the carriage is not injured, if the brakes do not act by jerks. On the other hand, some attention must be paid to the wheels; it is not certain, but it is probable, that the plate of a metal nave gets a set when the brakes are put on hard; after long continued shooting, therefore, the metal naves must be looked to, although even if the plate be bent the wheel is still serviceable.

Another fact to which attention should be drawn is, that with the present ammunition the observation of percussion shrapnel is easier than that of common shell; when the ground is soft or at long ranges neither percussion shell is of much use; it should not, therefore, become a habit to range a battery exclusively with percussion shrapnel, since with targets which are visible for but a short time, common or shrapnel with time fuzes give a quicker effect. We may indeed ask whether common shell might not, as a rule, be dispensed with in the field, except in peculiar cases, and shrapnel be thus employed for almost all purposes. This would allow us to give yet more attention to the different ways of ranging a battery with shrapnel. There would, moreover, then be no necessity to give the order for a change of projectile, which necessity is at present the cause that the Officer directing the fire is preoccupied, and that the "shrapnel-pauses," which can rarely be avoided, constantly take place. If only one kind of projectile were used, it would give better results than the two we now have; while the conduct of fire would be facilitated, and would be simpler, if only for the reason that it would not be necessary to count the rounds as they were fired.

It is again a question whether the corrections ordered for successive guns should be calculated from the last correction given or from the original elevation. Mistakes are more likely to occur if the correction be continuous, both on account of the elevating gear, and of errors which may be made; as soon as the system of firing by rounds throughout the battery[1] is given up, there is no reason why the correction should not be given from the original elevation; it is quite as quick and much more easy for the observer.

With respect to the use of guns at long ranges, the difference in the effect obtained is not a consequence of any failing in the material, which is quite sufficiently good. The reason why long-range fire is considered undesirable is on account of the difficulty of observation and of laying, when the atmosphere is at all misty or there is much smoke. A comparison of the results against the same targets, as follow:

Targets 12 and 16 at 1,900 yards, with 56 at 2,620 yards.
Target 59 at 2,020 against 22 at 2,300 yards.
Target 60 at 1,800 with 24 at 2,400.
Target 27 at 1,560 with 58 at 2,900 and 3,060 yards,

show that we can get good results at long ranges; but Targets 52 and 57 show also that there is a limit to this in practice.

Good effect should always be produced at ranges under 2,200 yards, and within this distance any visible or known target ought to be destroyed with certainty.

A quite sufficient effect may, in case of necessity, be expected up to 2,620 (see Targets 33, 35, 42, 45, 56); if the view be good, the service of the gun quiet, and the observation correct, this may be extended to 3,050; as regards ranges beyond this, many chances may intervene: in peace ammunition is too costly for such practice, in war it can too seldom be spared; see Targets 51, 52, 57, and 63.

The foregoing paper offers no final proof of the opinions given in it, as it is

[1] "Lagenweise;" firing by complete rounds, all the guns having the same elevation.—*N. L. W.*

not sufficiently complete to show entirely convincing results; it is but a beginning and a finger-post, to point out where certainty can be obtained, though it offers welcome material for this. The effect of artillery lies only in their shooting; it is therefore the only right way to consider all tactical formations from the point of view of fire-effect, judging them with reference to their good and bad influence on the shooting.

Supplement.

Further conclusions with regard to practice against recognized tactical formations may be derived from the following record, which forms a supplement to the tactical results of the course of practice for field artillery of 1890.

Practice of the 2nd September. At Thun.—A battery of 6 guns in position is fired on and is silenced (1). After a time a section of cavalry on reconnaissance shows itself (2); while these are under fire, some infantry appear, and are fired on as they extend, first the main body (3*a*), then the closed bodies of the first line (3*b*), and, lastly, the groups of skirmishers (3*c*).

1. 6 guns with detachments, at 16 yards interval, with the limbers 11 yards in rear of each gun, teams facing the rear. Range, 2,400 yards. 18 common and 18 shrapnel. Time, 15 minutes; interval between rounds, 25 seconds; battery ranged on No. 4 gun; distribution of fire, by sections after the small bracket had been found, by guns when shrapnel fire commenced.

Results.

	1 gun.	2 gun.	3 gun.	4 gun.	5 gun.	6 gun.	Total.
Limbers	24	52	51	42	10	166	345
Guns	15	39	16	53	9	40	172
Total	39	91	67	95	19	206	517

67 per cent. of the hits on the limbers, 33 per cent. on the guns.

Mean burst of common, 16 yards over.

Ditto of shrapnel, 55 yards short, 10 feet above plane.

87 dummies hit out of 96.

2. 24 cavalry dummies in swarm, half on a slope, the leading half under cover on level ground. Range, 2,460 yards. 10 common shell. Time, 3 minutes 30 seconds; interval between rounds, 21 seconds. 58 hits on 21 dummies.

Mean burst of common, 11 yards over.

3*a*. 3 companies of infantry in line of columns; each company in column of sections: each section two ranks of standing infantry dummies, and each 40 men; distance of rear ranks, 4 yards; interval between sections, 22 yards; 240 dummies. Range, 1,640 yards. 8 common and 14 shrapnel. Time, 9 minutes 30 seconds; interval between rounds, 26 seconds. Battery ranged on the centre company, and fire distributed when the small bracket had been found.

3*b*. 220 yards in front of Target 3*a*, No. 4 company with 3 sections at 4 yards distance; each section of 20 dummies in close order, kneeling and half under cover. Range, 1,420 yards. 13 shrapnel. Time, 5 minutes 45 seconds; interval between rounds, 26 seconds.

3*c*. 220 yards in front of Target 3*b*, the 4th section of No. 4 company, extended in 4 groups, each group of 10 kneeling dummies and 13 to 16 yards wide ; in rear of each group an Officer standing ; total breadth of the 4 groups about 66 yards. Range, 1,200 yards. 15 shrapnel. Time, 3 minutes 50 seconds ; interval between rounds, 16 seconds. Fire distributed from the first.

Mean burst of shrapnel, Target 3*a*, 83 yards short, 10 feet above plane.
Ditto Target 3*b*, 107 yards short, 13 feet above plane.
Ditto Target 3*c*, 137 yards short, 11·5 feet above plane.
Of 240 dummies in Target 3*a*, 213 hit.
Of 60 ditto, Target 3*b*, 59 hit.
Of 45 ditto, Target 3*c*, 42 hit.
The light was good throughout.

Distribution of Hits.

220 yds.	3*a*.	208	210	127		545
		208	127	136		471
						1,016
	3*b*.			235		
				92		
				92		
				419		419
		.	.	.	.	18
220 yds.	3*c*.	25	36	29	12	102
						1,555

Of the 1,555 hits the reserve, which contained three-fourths of the dummies (standing), received 65 per cent., the supports 27 per cent., and the groups 8 per cent.

If, in order to compare these results with those obtained in March (given in the former part), we calculate the danger of the several formations in the same manner, but, eliminating only the first 6 rounds of the entire 50 (since the fire was directed on the one battalion), we find—

No. of target.	No. of rounds.	Effective rounds.	No. of hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent.[1]	Ratio.	
1	36	30	517	17·2	1,238	2,400	114	141,177	
2	10	4	58	14·5	1,044	2,460	118	123,192	
3a	22	16	1,016	63·4	4,572	1,640	64	292,608	
3b	13	13	419	32·3	2,321	1,420	51	118,371	141,411
3c	15	15	120	8·0	576	1,200	40	23,040	
3 (*a*, *b*, *c*)	50	44	1,555	35·3	7,496	above	..	434,019	

[1] The natural tangent of the angle × 1,000.—N. L. W.

If we compare first the result on Target No. 1 with that given in the table on p. 178, it falls between the ratios of Targets Nos. 31 and 36, which were in the same formation; we may, therefore, conclude that our method of calculation of effect gives fairly useful and approximate results.

The proportion of hits on guns and limbers respectively corresponds also to the results on Target No. 31 (p. 149), and we may thus consider the approximate proportion of from 30 to 40 per cent. of the hits on the guns and from 60 to 70 per cent. on the limbers and teams as constant.

If we compare the fire on cavalry, we find that the ratio of Target No. 2 lies between Target No. 42, the half-column and Target No. 63, the column of sections (p. 157), a position which, considering the fairly considerable depth (22 yards) of the swarms, and the relative closeness of the formations, appears to be probably correct.

The greatest interest is attached to the comparison of Target No. 3 with the tables referring to infantry targets. Taking, first, the whole battalion, the total is in excess of any in Table I (p. 159). This excess is to be ascribed to the fact that the formation given to the target has a considerable depth in the centre and is also relatively close. Of the 1,555 hits, 56 per cent. are on the centre, including skirmishers, supports, and the centre reserve company, while the flanks of the reserve received only 44 per cent., and this, although the front half of the centre consisted of kneeling dummies only, while the leading eighth part has considerable intervals. Since the flank reserve companies are in the same line as the centre company, the fire can be easily distributed along that line; it is owing to this circumstance that, as has already been shown, the line of columns is the most dangerous formation. The depth of the sections, though only 4 yards, is sufficient to make them a very unfavourable target, as was also evident in the case of the closed double line of Target No. 32, where the distance was only 1 yard. From this practice we may also draw the conclusion, that in all cases where infantry stand in line, and the fire of artillery can thus be easily distributed along it, the depth of the formation should be as small as possible, as soon as the troops are halted; when they are moving, in which case the risk will always be less, the distance between ranks or lines must be a minimum.

If the ratio of effect on Targets Nos. 3*b* and 3*c* be compared to those in Table II (p. 162), we shall find that it falls between Target No. 45, the column of fours of the company, and Target No. 60, two separate subdivisions in columns of sections, and thus above those company targets in which at most two sections were held in reserve, and in which the reserve and the supports were not on the same line. Whilst in Targets Nos. 55 and 56 of the above 38 per cent. of hits fall on the two reserve sections, 39 per cent. on the section in support, and 23 per cent. on the skirmishers, in Targets Nos. 3*b* and 3*c* we find 78 per cent. on the 3 supporting sections, and 22 per cent. on the skirmishers; this result is derived solely from the depth and closeness of the formation of those supports, and confirms the conclusions which have been already stated with regard to the progressive increase of danger with each increase of depth of formation.

Target No. 3*c*, taken alone, may be compared with Table III (p. 164), and falls, if multiplied by 2·5 (giving 57,600), between Targets Nos. 54 and 38; this good effect may be ascribed to the circumstance that the four groups formed distinctly separate targets, on which the distribution of fire was easy and exact.

It would be very advantageous if, during the service practice at the schools of instruction, and especially during the advanced course, other formations could be submitted to actual trial under artillery fire; theoretical formations would then prove their efficiency or the reverse, after having been literally "tried in the fire."

RED INDIAN WARFARE.

By the Author of "The Campaign of Fredericksburg."

I.

THE sober narratives of travellers and sportsmen have altogether dispelled the halo of romance which, thanks to Cooper and Mayne Reid, once enveloped the aboriginal tribes of North America. That "all Indians are pisen," need not be accepted in its integrity; but it is a statement, nevertheless, with which most people are inclined partially to agree, expressing as it does the conviction that as a race the red man is an excrescence on civilization, and a product of Nature whose absence would not be regretted. It is possible that this feeling is accentuated by a consciousness that the "Indian question" is apparently a problem the solution of which would be very greatly facilitated by the elimination of the main factor. Better than undergoing the humiliation of confessing that there is a question with which the wit of man is powerless to deal, is to make it impossible that such a question should exist. As the process of extermination, gently administered by the aid of "fire-water" and epidemics, is supposed to be gradually bringing this desirable consummation within reasonable distance, the popular interest in the present troubles in the Western States of America is by no means warm. Still there are lessons to be learnt from the story of the endeavours of the United States Government to fit the original occupants of the continent into their proper place in the puzzle of civilization. Hitherto the pegs have all proved round and the holes square. But both philanthropists and statesmen may gather wisdom from the experiment; whilst soldiers, who have so much to do with reducing the pegs represented by savage tribes to a shape in which they can be operated on by civilian hands, may find some useful suggestions in the practice of their American comrades. If there is nothing novel in this practice, a brief glance at the sort of work that occupies and trains an Army with which, both in race, in speech, and duty, we have so much in common, ought at least to prove professionally interesting.

Personally and mentally unsavoury as he is, the Indian is still the first character to be introduced. If his part is not one which commands our sympathy, we must at least allow that it is most essential to the plot, probably contemplated by himself with an absorbing and even painful interest, and certainly played with an uncommon deal of skill. Divested of his heroic trappings as he has been, not even the author of Hiawatha himself, if he were still living, would dare nowadays to apply to this Christopher Sly of real life the epithet of "noble." And yet he has scarcely been brought down, like Shakespeare's hero, to the level of "a rascally tinker" at a single plunge. Unprejudiced observers have recorded their belief that he is not altogether infamous; that if he is treacherous, the white man has not set him a very bright example of truth-telling and word-keeping; that if he is merciless, he has never been shown what mercy is; that if he spares neither sex nor age, the pioneers and trappers, so long his enemies, were not too particular whether the "varmint" they "wiped out" was buck or squaw; that if he gloats over the tortures of his prisoners, he is ready himself to face the same fate with stoical composure.

"I am not disposed to be over-fond of Indians," writes Lord Dunraven, who knew them well, "to gloss over their faults, and magnify their virtues. But still I am fond of them. I respect their instinct;

I admire their intense love of freedom; and, while admitting that Cooper's heroes are somewhat imaginary, I must confess that the 'noble red man' is not altogether such a mythical being as one school of writers would have us believe. He has some noble and excellent traits of character, and it must not be forgotten that although certain of his natural actions and thoughts are shocking to our ideas of decency and morality, yet the chief causes that render him obnoxious to us are to be traced directly to the contaminating influence of the white man. Indians, though sometimes mean and treacherous, yet often exhibit a grand simplicity and nobleness of character. As a rule, they exercise great self-control, though now and then they break out in wild orgies and excesses of all kinds." Nor does he rate very highly the capacity for "getting religion." "I will not stop," he adds, "to calculate how much tea and sugar, pork and tobacco, suffice to convert a tribe or individual; or to notice how, in consequence of this peculiarity among the natives, Christianity rules high in years of scarcity, and has a downward tendency when buffalo is scarce."

This is a scanty tale of virtues at best—American soldiers will even be inclined to cavil at the existence of the most prominent items—and if, at the same time, it be admitted that, however courageous he may show himself when all hope is lost, his measure of actual physical courage is best compared to that of "a rat in a corner," the red man of North America ranks low in comparison with other savage peoples with whom we have acquaintance. But if he lacks the disciplined valour of the Zulu, the fearless fanaticism of the Ghazi or the Soudanese, it is due, perhaps, rather to the influence of the tactics he has inherited from his forefathers, and to the consciousness that, in their overwhelming numbers, his enemies can afford to waste the lives of a hundred soldiers where he cannot spare that of a single warrior.

At all events, what he lacks in daring he makes up for in intelligence and craft; and Lord Dunraven supplies a passage that tends to prove that their very deficiency in *élan* is, perhaps, only a consequence of different modes of thought.

"Judged by our standard," he says, "the Indians are, as a rule, cowards; and we suppose, therefore, that they must be convinced of our superiority in courage. Not a bit of it. They look upon our bravery as the height of folly, and find us lacking entirely in those great qualities they so much admire. We cannot endure the tortures of physical pain or starve as they can. Their mode of carrying on war is quite dissimilar to ours, and they do not appreciate that desperate, bull-dog courage that leads a soldier to struggle to the bitter end against overpowering odds; nor do they highly esteem a man who is ready at all times to sacrifice his life for the cause. On the contrary, they would regard such an one as a fool, who had parted with a valuable commodity, namely, his life, without obtaining an adequate return for it. Those chiefs are disgraced who bring back the war-party with diminished ranks. Occasionally they make up their minds to a great effort, and expose a number of lives to compass the destruction of the enemy, as in the case of the Fort Kearney massacre, when the Indians lost severely, but killed, if I remember aright, over eighty officers and men. . . . They are not very prone to fight, and their great object in war is to do as much damage as possible without the loss of a single man. . . . A life is very valuable to them. Hence it is that they admire the man who can creep and watch, and lie out for days and nights in the bitter cold and snow without food or warmth, and who, by infinite patience, cool courage, and a nice calculation of chances, secures a scalp or a lot of horses without risk to himself, but who, if he found the circumstances unfavourable and the odds against him, would return without striking a single blow. That is the man they look up to. So we do not impress them a bit by our superior bravery. They view with indiffer-

ence the reckless courage and devotion upon which we set such store, and value very highly the qua..ties which we are inclined to despise. . . . While fully acknowledging the fact of our preponderating strength, while seeing plainly before them the extermination of their race, and bowing their heads to sad necessity, they will not admit that we are in any respect their equals, man to man. They are the most strong-hearted, hard-headed people in this matter, submitting to the inevitable, but steadily maintaining their self-respect."

Such is the foe with whom American soldiers have to deal. Wily with a craft that no other savage race can equal, and which long years of experience in frontier warfare scarcely enables the wariest trapper to counteract; unscrupulous in his methods, deeming the grossest treachery perfectly fair, and, if successful, the highest triumph of strategy, he joins to matchless and inexhaustible patience a ferocity which renders death or capture a hundredfold more horrible, and which blazes out sometimes in the resolute fashion of a desperate charge.

Of all tactics, those of the Indian are the most uncertain. He is an enemy whom it is impossible to despise. Under no circumstances is it possible to calculate what he will do next. He has no weak points; surprise alone affects his morale, and there are, therefore, no special tactical methods, as is the case with other savage tribes, that can be followed in Indian warfare. He has no cattle to lose, and the destruction of his wigwams, so easily renewed, is of far less moment to him than the razing his kraal to a Zulu or of his ancestral village to an Afridi. So vast are the territories over which he roams, so barren in food, so impassable in winter, and with such speed does he travel, that it is an exceedingly difficult business for troops, encumbered with a convoy, to bring him to bay. His system of reconnaissance is so perfect, that it is next to impossible to approach his camps without his receiving ample warning. He is much too wary to be found "at home." The ashes of his fathers have no local habitation; the temples of his gods are the prairie and the forest; he has nothing to defend save his own life, and there is no single spot of earth where association or sentiment draws him to his doom.

There are many extraordinary stories told in the American army of pursuits which went on month after month, of marches which exceeded in their total of mileage a line drawn half way across the face of Europe, and which ended in the surrender of the war-party, worn out at last by the superior pertinacity of the white man. But there are many more instances where the trail was lost, then some waterless desert put a barrier between pursuer and pursued, or lack of food and forage utterly exhausted both man and horse. In 1886 was seen the extraordinary spectacle of 4,000 men, a sixth of the whole regular army of the States, pursuing 50 or 100 Apaches, under the robber chief Geronimo, across the deserts of the Chihuahua country for a whole year, and failing in their purpose of capturing the band.

But the growth of the United States, and the wanderings of her restless population in search of gold or pasture, has put a limit to the prairies. Railways and roads encroach everywhere on the vast expanse which was once free to the Indian, whether hunting the herds of buffalo and wapiti, or hunted himself by a party of dragoons. Towns and villages, forts and ranches surround the hunting grounds that the policy of the Federal Government has reserved for the aborigines. The telegraph poles are conspicuous objects in the wildernesses of the West. There is little chance of escape for the Sioux or Cheyenne who dwells in the northern States of Dakota and Nebraska; although, far away in the south-west, the Comanche, Apache, and Arapahoe can still find a sure refuge in the deserts and mountains of Texas and New Mexico.

But if he has lost in one respect by close contact with the advanced guard of civilization, the Indian warrior has gained in another. Just as in times past, although the horse was at first a being as terrible to his unaccustomed eyes as the "child of the sun who bestrode him," he soon learnt to utilize the capacities of the animal to the very utmost, so he soon learnt to appreciate the value of the rifle. And when once he had discarded his primitive weapons, he did not rest content with an inferior firearm. His fighting instinct was too true to overlook the advantages of each successive improvement; and the war-parties of to-day are armed with Winchester repeaters, and revolvers of the latest pattern. At the same time, although their skill in horsemanship and subtlety in tactics is universally admitted, the accuracy of their marksmanship is often questioned. In the numerous excellent periodicals devoted to the military service of the United States are to be found many articles bearing on the characteristics of Indian fighting, and it seems that, amongst the younger officers at least, there is a tendency to depreciate the skill at arms of their savage enemy. This may, perhaps, arise from the fact that young officers are often inclined to put too high a value on the statistics of annual musketry practice, and to condemn all shooting as bad which compares unfavourably. But those of wider experience, who understand the influence of "nerves," and the demoralizing effect of changing places with the target, hold different views. General Wesley Merritt's opinion is worth quoting. "The Indian of the plain," he writes, "is a perfect light horseman. His strength is in his capacity as a horseman and his powers as a marksman. . . . They use firearms with great accuracy when mounted, even in rapid motion. Their horses are trained, as well as the riders themselves; they halt, and stand steady on an indication from their riders, stand still without holding when their riders dismount to fight on foot." General Gibbon, a name as honourably known in the Secession War as in frontier expeditions, speaks very decidedly on this point, and tells us that it is not only in this essential to good skirmishing that the red man excels. "We cannot but be impressed," he writes, "with the almost unlimited capacity for marksmanship that the Indian possesses. The process of instruction in the use of firearms has been going on for nearly three-quarters of a century, the arms improving with the marksman, and the marksman with the arms, until at the present day an Indian who cannot hit an object the size of a man at the distance of 400 or 500 yards would be ridiculed by his comrades and laughed at as a squaw. The day then for our troops to meet these warriors when outnumbered ten to one is past. Nay, more than that, they cannot contend against them successfully man for man, except under the most favourable circumstances, and then only by adopting the improved tactics of the Indians themselves. . . . Indians never act in masses, except under the most desperate circumstances. We frequently hear accounts of the most desperate acts of bravery by individual Indians, but these are usually isolated cases. An Indian who would *unnecessarily* expose his life with no prospect of benefiting his comrades would be looked upon as a fool. The absurd spectacle of the two idiots who stepped in front of their commands, and with bows and salutes begged that each might first open fire, has no place whatever in Indian warfare. The Indian's delight is to take every possible advantage of his enemy; to surprise him if it is within his power, and do him all the harm he can, without suffering any himself. . . . He will crawl and wriggle like a snake, or lie still as a statue for hours and hours, that he may gain certain information or an advantageous position. In action he takes advantage of every possible inequality of the ground, a stump, a stone, a buffalo wallow, anything to conceal him from your sight whilst you are exposed to his. They fight as *individuals*, and still appear to be under control of their chiefs. A single warrior will ensconce himself

behind a rock, or up a tree, and there for hours pick off man after man with his unerring rifle, seemingly unmindful of the chance that he may be surrounded by overwhelming numbers and cut off from all help. . . . Herein lies his great advantage over an enemy drilled to fight in a body. The drill of men in masses, and the 'elbow touch' of the regular soldier, admirable as they are in ordinary warfare, are utterly thrown away in contests with the Indian. We must drill our men to rely less on each other and more on their rifles, and impress upon them how formidable a single rifleman is when, protected himself, he knows enough about his weapon to pick off men at 400 or 500 yards. Hence in fighting Indians good marksmanship is the first requisite, for we have to contend against the *best marksmen in the world.* . . . Hence *practice, constant practice,* must be had in order to perfect our men in the use of the rifle."

As regards the introduction of a magazine rifle, he says, "It would be better to allow plenty of ammunition for practice, for without skilful marksmanship a magazine gun would only increase the waste of ammunition without a corresponding increase in its effect. We had better follow the example set us by our enemies, the Indians, who very seldom fire with great rapidity, and who make up for their smaller number of bullets by increased accuracy." General Gibbon is also an advocate for the hair or rifle trigger. "No man," he says, "can shoot accurately a rifle which requires a 7-lb. weight to be brought to bear upon the trigger;" and he attributes the good marksmanship of the Indians and the trappers to their habit of easing the pull-off of the rifle, as well as to their dispensing with the elevating sight, and learning by experience "how much of the front sight should be seen between the horns of the rear sight in order to reach certain other distances beyond point blank." "The only reason," he adds, "I have ever heard against the proposition to place suitable triggers upon the rifles is the fear lest *somebody should be hurt.* Now *that* is just what we want; and if, in preparing ourselves to hurt somebody, we kill or maim a few of our men by premature discharges, we can console ourselves with the reflection that *in the aggregate* we have saved life. But the fact is that it is no longer an objection against placing a *rifle* trigger upon a rifled gun, for the breech-loader is very seldom charged except just before using, and those who refuse or fail to give us an efficient rifle must be placed in the same category with the old woman who would not let her boy go near the water till he learned how to swim."

It may be the case, however, that skill in marksmanship differs in different tribes; but, be that as it may, there is no doubt, when we consider the varied qualities enumerated above, that the Indian is a most formidable foe. Fortunately for the United States, the same conditions which have so often proved favourable to ourselves are in force in Indian polity. Like other savages, they are incapable of combination. Numbering no less than a quarter of a million souls, it has been calculated that of these a seventh are braves; that is, to 25,000 American soldiers, the strength of the United States regular forces, are opposed 35,000 warriors.[1] But the tribes are scattered over the whole length of the northern portions of the continent, from Canada to Mexico, a distance of more than 2,500 miles as the crow flies; and, if they hate the white intruders, the tribal feuds, which gave the fighting men occupation before the strangers set foot upon the prairies, still rage with unabated fury. No Indian Hannibal has yet appeared to weld together the antagonistic elements of which redskin nationality is composed.

The policy of the United States towards these embarrassing savages has been, in principle, a generous one. To police the vast frontier so thoroughly

[1] This is probably much under the mark. Some writers estimate the Indian population at 400,000.

as to restrain the frontiersmen in their dealings with the Indian, to mete out strict justice in the incessant quarrels that made the debatable ground of the Far West a region where the life of man was held on the most precarious tenure, to nip these quarrels in the bud, and to eradicate their causes, is a work which is still far from consummation; but, by giving over to the Indians vast tracts of territory within which limits the tribes are free to follow the chase, to raise cattle, or even to make attempts at farming, without interference, and by preserving these tracts, in theory at least, from the encroaching tide of emigration, the Government has done its best to adjust the claims of the original lords of the soil with the needs and enterprise of the whites. Some of these tracts, reservations as they are called, are of great extent. That assigned to the Crees, the Cherokees, the Seminoles, and other nations, to the north of Texas, measures 250 miles from north to south, and 350 miles from east to west; and that occupied by the Sioux in South Dakota, the scene of the recent rising, contained a few years ago 43,000 square miles, an area a good deal larger than Ireland. There are many other districts over which the red man is allowed to hold undisputed sway; and it would seem that even the most restless nomad should be content so long as he possesses the power of indulging his wandering propensities within such lordly limits. But there are deeply-seated characteristics to be reckoned with. The love of freedom; the sense of injustice, for the Indians, far from realizing the truth that the earth is free to all, still cherish the belief that the Good Spirit made the prairies for his red children, and for them alone; and, lastly, the bitter hatred of the white intruder, engendered by long years of hopeless warfare and intensified by tradition. It is scarcely to be wondered at that such feelings, so carefully nursed, should sometimes kindle an irresistible impulse for vengeance and revolt.

Nor are other causes lacking to fan the flame. Considerate as has been the policy of the Government, the system under which it has been applied has been found wanting. The agents, that is the Commissioners, who have charge of Indian affairs, and carry out the contracts between the tribes and the sovereign power, are selected, as a rule, not from men who are intimately acquainted with the tribes, and have passed a long probation in the Department, but from political adherents of the Administration; they are often without experience of frontier life, and, in almost every case, appointed only for a term of years. It is notorious that such men have over and over again yielded to the temptations of their positions, and have grossly abused their powers. Their opportunities of making money at the expense of the people with whose well-being they are entrusted are so many, and their chances of detection, far removed as they are from all supervision, so few, that many have accepted the position with no other idea than that of amassing a fortune before a change in Government necessitates their supersession. This has been the great blot on the administration of Indian affairs, and it is impossible not to regret that the ludicrous jealousy which exists in the United States of the regular army should have led Congress to disregard the very cogent arguments which, time after time, have been brought forward as to the advisability of handing over the Indian Department to men who not only thoroughly understand the people with whom they would have to deal, but who are under constant supervision, and for whom ill-gotten gains would prove a sorry compensation for the loss of honour, friends, and reputation. On this point, America might well take a lesson from the political branch of the Government of India.

One effect of the confinement of the Indians within comparatively narrow boundaries has been the gradual disappearance of game. The buffalo, which once provided food and clothing to every single individual of the tribes, has become a zoological curiosity, and the few hundreds that survive of the

countless herds which but a few years ago roamed the length of the continent, are with difficulty preserved in the National Park of the Yellowstone river. It was found necessary by the Government, therefore, when the Indian hunter could no longer rely on his rifle to provide sustenance and shelter for his family, to dole out rations of beef and supplies of blankets. And not only have frauds been frequent, and the Indians cheated by dishonest agents of the provisions which the promises of the Government had assigned to them, but Congress itself has been to blame in cutting down the amount of the ration without consulting its agents, or taking into consideration the circumstances of each individual case. The sudden reduction of the annual supply of meat rations from five to four millions, with the result that the Indians were obliged to kill their own small herds of cattle, and were prevented from attending to the sowing of their scanty harvests, was undoubtedly the cause of the recent outbreak in South Dakota. We may also note that the supineness or connivance of the agents has permitted traders, whose patriotism bears a "Brummagem" stamp, to deliver large consignments of arms and ammunition in Indian territory. "Only two years ago" (1876–77), writes General Gibbon, "when the whole Sioux nation was arrayed in arms against our little force in the field, boat-loads of arms and ammunition were carried up the Missouri river, which were certainly not intended for the Government troops."

But, besides his just complaints against the political system, and the roguery of some of its agents, the Indian has other incentives to revolt. He is more than a hunter. The hide of the buffalo, the fur of the beaver, or even the claws of the grizzly, are by no means his most cherished spoils. The chief ornaments of his lodge-pole are not the trophies of the chase, but the trophies of war—not, indeed, the weapons of the enemy won in open battle, the "spolia opima," but the dreadful evidences of that cruel cunning which cares not for age or sex, so long as the ghastly decoration was torn from the head of an enemy, fairly or foully killed. Courage and craftiness, according to Lord Dunraven, are virtues highly prized in Indian communities. "The brightest smiles, the sweetest glances await the youth fortunate to have struck an enemy. He becomes a man; his words are believed with respect; his friendship is courted; his love not often refused. The old women tell the girls long stories of what men their forefathers were, and descant upon the doughty deeds they performed before daring to aspire to the hand of their mistresses. The vanity of the 'dusky maiden' is aroused; she determines not to be too cheaply bought or too easily won; and she taunts and goads her lover into some act that frequently brings a terrible retribution, not only upon him alone but upon whole families and tribes of innocent persons. Can we not imagine the scene? The lovers pacing the moonlit sward, chequered with the drooping shadows of the pines, the rustle of the trailing robe, the twinkle of the little feet among the flowers, the flame of the tender eyes, the throbbing pulse, and beating heart, the gentle pressure of the hand, the warm soft rounded form yielding to the persuasive arm, the whispered 'Darling, wilt thou be mine? fly, oh, fly with me to yonder grove, there to plight our troth and swear eternal constancy.' And the prudent reply, 'Yes, dearest, I am sure it would be very charming, but what would papa say? How many scalps have you got? How many horses can you steal? Have you taken any ponies lately, nice piebald ones?'

"Fancy his conscious blush of shame, and her indignant, 'What! have you killed nobody yet? Unhand me, villain! Is it thus you dare to address the daughter of "The skunk that creeps in the grass?"' No! I don't think the young brave is to blame. What can he do? 'Needs must when the devil drives'; and, if the old story of St. Anthony's temptation is to be credited, there lurks in the sweet smile and slyly inviting glance of

woman the most dangerous and irresistible imp of the whole Satanic crew."

Now, it is probable that the less romantic pleadings of an empty stomach have had more share in bringing about Indian war than the promptings of love and vanity, but the fact remains that the Indian is, beyond all, a warrior. War is his trade, hunting merely an essential accessory; and he, therefore, needs but little excuse, conscious though he be of the enemy's overwhelming superiority in numbers and resources, to take the war-path against the "long-knives." That he is capable of being slowly and by gradual degrees broken in to civilization, the success which has attended the first efforts of the Indians in peaceful living and self-government is sufficient proof. The Indian Territory, already mentioned, is by no means the least orderly nor, in some respects, the least prosperous district of North America. The Cherokees, a nation of 20,000 souls, maintain excellent "schools, two seminaries, and an orphan asylum; and they have a weekly newspaper, printed mainly in their own language." All the civilized tribes have their own legislature, their own courts, and their own police. The people are self-supporting, living on the produce of their clearings and the sale of cattle, and "the thriftier among them," says an American writer, "are doing as well as average white farmers in the States." Their prosperity was much greater before the Secession War. Unfortunately for themselves they were tempted to take part in the conflict. They were rich, and had become slave-holders, and their assistance was courted by either side. Their share in the struggle was not a glorious one. Engaged in the desultory warfare that was carried on in Texas and along the western frontier, they were not called upon to make any great exertions; and it was evident that long years of peace had sapped their natural aptitude for war. There were signs, however, that this aptitude had not altogether decayed, for at the close of the war a full-blooded Seneca Indian was serving as a Colonel on the Staff of the Federal Commander-in-Chief, and was amongst the witnesses of the historic interview between Grant and Lee.

But there are many tribes that are still untamed, and it will take years before they learn to submit to the inevitable, to labour for themselves; possibly not till the present generations have passed away, and chiefs take their place who have been educated as children, and taught to respect the laws and institutions of civilized society. The process must needs be a long one; and if patience, and, above all, the strictest justice and a proper recognition of Indian rights, do not preside over it, the United States Army will have many more such campaigns as that which appears, at the moment these lines are written, to have come to a satisfactory close. The American press, however, seems to apprehend that there is little likelihood of permanent peace. "Our treatment of the Indians," says the "New York Herald" of November 4th, "is an infamous chapter in history. We may as well say it, because it will be said and remembered centuries after the last Indian has vanished. And those who will bear our names and be nourished with our blood will wonder why a nation which vaunts its enlightenment should have treated the Indian in so inhuman and merciless a manner. We have taken his lands, broken every engagement, driven him upon reservations, and turned him over to be plundered by professional politicians. We have taught him fatal habits, and provoked him to exterminating ones, but have never taken seriously in hand the problem of his civilization. In a kind of shamefaced, reluctant way we established the Indian Territory, but that will soon fall under the hammering of the speculators and politicians. Conscience may be satisfied by calling it destiny, or fate, or some such name. But history will call it selfishness and crime. . . . . Even now, a definite, humane policy on the part of the President would shed a

glow of satisfaction to the heart of every American who feels the irreparable wrongs that have been heaped upon the Indian race."

II.

Putting philanthropy on one side, and looking at the question from a purely professional point of view, it would scarcely be to the benefit of the United States Army were it to be deprived of its school of practical training. It is true that Indian fighting teaches few lessons immediately applicable to civilized warfare, but as regards the formation of what Von der Goltz calls a martial character, the fostering of initiative, and the power of accepting responsibility, the capacity for quick decision, habits of vigilance, readiness and coolness in grave emergencies, as regards all these it has been of the greatest value. The experience in campaigning, the knowledge of commissariat needs, of the selection of camps, of marches, of the care of men and horses, and reconnaissance—matters of far greater importance than skill in evolution and grand tactics—gained in the frequent expeditions to the Far West, bore full fruit in the Secession War; for, without doubt, the capacity which was so marked a characteristic of the regular Officers on both sides was due as much to their long service on the frontier as to their preliminary training at West Point, or to the Mexican campaigns of 1847–48.

A glance at the country which has been the theatre of the fiercest Indian fighting during the last forty years, and still promises further trouble—the country which was originally the hunting ground of the warlike Sioux and Cheyennes—together with a brief sketch of some of the principal expeditions, will perhaps make clear the extraordinary obstacles which awakened the ingenuity, perseverance, and resourcefulness which was so marked a feature in the long conflict between "the blue and gray."

The original domain of the Sioux was indeed royal. It was larger than France, England, and Germany combined. More than two centuries ago, when the French explorers and missionaries, moving westward from the lakes, first found them, the Sioux, otherwise known as Dakotas, occupied nearly all of what now is Minnesota, North and South Dakota, besides much of Wisconsin and part of Iowa and Nebraska. In 1837 much of this country was ceded to the States; and in 1862 reservations were selected in the western part of the territory. Since that time, little by little, the hunting grounds of the tribe have been narrowed within comparatively small limits, although their property still embraces an area greater than that of the States of Massachusetts, Connecticut, and Rhode Island combined. Dating from the year 1855, when the Sioux first came into collision with the Government troops, and, after a success over a small detachment, were heavily defeated by General Harvey, the prairie country between the 42nd and 47th parallels of latitude, and between the Missouri River and the Rocky Mountains, 600 or 700 miles in length by 350 in breadth, an area greater than the whole of the German Empire, once their own undisputed possession, has been their battle ground.

Of the attractions of great prairies, the sense of freedom created by their very vastness, when, week after week, the traveller sees apparently the same horizon outlined against the setting sun—the same trackless expanse of grassy undulations, stretching far away on either hand, where the shadows of the clouds alone have life and motion; of their pure air, their gorgeous sunsets, the exquisitely delicate colouring of earth and sky, their inexpressible loneliness, and, at the same time, of the fascination which leaves those who have once beheld them with a never-dying longing to return, we have read in the pages of Ruxton, of Butler, and Dunraven. But these very attributes, combined with the intense heat of the summer and the rigour of

the winter, render the interminable plains which lie between the Missouri and the mountains as difficult a field for military operations as the Atlantic itself. Nor, as we approach the hilly country, do the difficulties decrease. The Black Hills, the western boundary of the Sioux reservation, are well timbered and well watered, and hold in their recesses valleys which contain all that man or beast can desire in the way of food, shelter, and water ;[1] but the great range of the Rockies—with its stupendous cliffs of granite and limestone—through which the mountain streams have cleft a way in cañons whose depths are hidden in perpetual darkness—with its pathless forests and its blinding storms of snow, offers a fastness to the savage that is almost inaccessible to the soldier. On the prairies themselves summer marches are made intolerable by dust and want of water. In the winter, snowdrifts and blizzards, with the thermometer often at 30° below zero, are even more destructive of strength and energy. Winter has only one compensation, that then the white surface of the earth shows the tracks of the flying foe. In summer, even the most reliable of scouts often fail to detect the path of the war-party over the dry, bare slopes of the sun-scorched ridges. It is true that on the prairies camping places, with wood and water in plenty, can be found by the experienced, but of other supplies there are none. The rattlesnake is the only creature that now inhabits the great pastures of the buffalo ; and the convoy that carries its subsistence and stores is as essential to the efficiency of the column as it is an impediment to its progress. A long train of mules and wagons, except in cases where railways and agencies are close at hand, and there is no need to cut adrift from the base, is a necessary adjunct to the force that moves across the prairies, and, although the going as a rule, is perfectly good, the rivers that cross the trail cannot be crossed without precautions and delay. Cutting deep into the alluvial soil, they run between high bluffs and wooded banks, and ramps have to be constructed to permit the passage of guns and wagons. The path of the column, moreover, is seldom clear. Now and again it follows an Indian trail, trodden by the hoofs of many a war-party ; sometimes it is directed on one of these strange, isolated hills, "buttes," in the trapper's patois, starting suddenly from the surrounding level, which are landmarks of the hunter and the map-maker ; at others it follows the unerring instinct of the Indian scout, but often the compass is the only guide. But there is worse to come. East of the Black Hills, and north of the Pine Ridge Agency, are the Bad Lands, a great tract of country that is almost impassable for wheeled traffic ; badly watered with streams so charged with alkali as to be most almost undrinkable ; dreary to the last degree, with a soil of clay that supports no vegetation, that breaks up into a finely-ground dust in summer, and becomes in winter a greasy, slippery, fathomless mass of mud ; a district where the thinnest cactus grass flourishes only in unfrequent patches, and where wood is almost entirely wanting. This geological phenomenon is the citadel of the Sioux ; and we have seen, in the last campaign, that it forms a safe rendezvous for their gathering bands, and a refuge in case of disaster in the open field.

The nation of the Sioux is a startling proof against the supposed natural decay of the Indian races. Seventy years ago it numbered 13,000 souls. "Since that day," says the "N.Y. Herald," " they have had many struggles with soldiers, settlers, starvation, small-pox, Indian agents, and other torments, yet now they number about 50,000." As to their fighting force, opinions differ very considerably. It is variously set down at something between 12,000 and 5,000 braves.

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[1] Within the last few years these hills have been "settled up" by miners and prospectors.

Holding a country such as has just been described, it is evident that even a much smaller total of trained warriors, with an apparently unlimited supply of horse-flesh, must prove an enemy exceedingly difficult to subdue; and if the campaigns of the American army resemble in many respects the prolonged operations of our own troops in Zululand and the Soudan, it is because both the nature of the country and the tactics of the opponent are utterly unlike anything that is met with in civilized warfare. Be it remembered, that to European ideas everything in America is huge and stupendous. "Nature is formed in a larger mould." The mind accustomed to the confined limits of a European country scarcely realizes what distance means in other continents. Nor, accustomed to the network of roads which covers the least fertile tracts of the Old World, to teeming populations, and a multitude of cities, does it appreciate the difficulties which crowd thick upon the soldier in those trackless deserts of Africa and America, each vaster in itself than the greatest states of continental Europe, and yet but an infinitesimal portion of the whole. We look on the map when some expedition in distant countries is in progress, and follow its movements from day to day, half inclined to grumble at its slowness, for it seems to make no appreciable advance, to linger long about the border, and at the end of all has penetrated to what seems only a few short marches within the boundary. But the scale of the map is one with which we are unfamiliar; and as, to use Arnold's simile, he who for the first time looks up at the great dome of St. Peter's fails to realize its true proportions, so we are apt to underrate the exertions of the troops in those far-off regions on which our eyes have never rested, and to compare them unfavourably with campaigns near at home, where the distances to be traversed are small, the natural obstacles insignificant, and the operations facilitated by all the resources of civilization.

In civilized warfare, moreover, an invading army will, sooner or later, find his path crossed by the main body of the enemy. One side takes the initiative, the other the defensive. The *rôles* are inevitable, and it is merely a question of days when the defender will have to stand his ground. And when he once takes up his position, he cannot escape without a battle, except by his adversary's leave. The mobility of modern armies is but a lumbering quality after all. But it is far otherwise with the savage. His mobility is only limited to the utmost speed of his horse, or of limbs which, in the case of the Zulu outstrips the activity of even the lightest cavalry. He has no capital to cover, no communications to guard. Seldom can he be bound to the defensive. Invader though you be, he will choose his own time and place for battle, and sets all rules of strategy at defiance. If he is defeated, each individual chooses his own separate line of retreat; it is impossible to annihilate the band at a single stroke; and he is apt to regard the disaster as due rather to his own bad choice of opportunity than to your superior skill. All of these, then, must be borne in mind when we study the tardy operations and indecisive engagements of savage campaigns, and especially of those in which the enemy is the North American Indian or the Arab of the Soudan.

"In 1862, when the flower of the regular army was engaged against the Confederate States, the Sioux of the north-west attempted to retake their old hunting-grounds. Many settlements were destroyed, many whites were taken, and more than a thousand killed. Troops were promptly sent to the border, however, and compelled the Sioux to cry quits, and to give up many of the women and children they had captured. The moral effects of the defeats they suffered were so great, that many of the Indians fled into Canada, whilst others hid themselves in the mountains. In 1866, a general treaty was made, and there was an attempt made to induce the tribes to take to agriculture. But whilst the buffalo existed, the majority preferred to live on such meat as they could get, and to depend upon the wretched rations which

the agents supplied, rations which were seldom up to the quality and quantity agreed upon." Peace endured for only a short time. From 1873 to 1879, a craze for scalps, brought about, in great part, by the frauds of the agents and failure of the U.S. Government to redeem its promises, spread over the debatable ground. Numerous expeditions and many sanguinary combats were the result, and of these the long campaign against the Nez-Percés, in 1875, was, perhaps, the most remarkable.

The outbreak of this tribe, one of the bravest, and at the same time most friendly to the whites, began, as usual, in a quarrel about land. A beautiful and fertile valley had been assigned to a portion of this people; but two years afterwards the order was revoked, and the chief was ordered to remove to another reservation. The Indians resisted the decree, at first in words only; but at length, after the question had been discussed for ten days at the council fire, on the last day "two young men, whose father had been killed by the whites, took three companions, and committed the first murders." Two companies of cavalry and a body of volunteers were immediately sent to exact retribution. "Our advance," says an American writer, "was met by nearly the entire hostile force, 300 warriors. Leaving the women and children in the camp behind them, they advanced, throwing out a line of mounted skirmishers, which deployed and manœuvred in fine order. They came on yelling, under cover of a herd of horses driven ahead of them, and by military skill and savage adroitness combined, they soon turned our flanks, and poured in a deadly fire. The citizen volunteers broke and fled, panic-stricken. This demoralized the soldiers, and the sad affair was only saved from being a rout and total massacre by the coolness of the few who preserved military order, and thereby escaped alive. The Nez-Percés returned to their camp completely victorious, and probably suffered very slight loss."

After this first engagement, all the troops in the department were collected, and for nearly a month the Indians were followed through the mountains of Idaho, the western spurs of the Rockies. The Nez-Percé chief, Joseph, gained another success, penning two companies of cavalry in a stockade, and destroying a reconnoitring party of an officer and ten men.

He then went into camp, and waited the arrival of the pursuing column. "It was a test case—all the hostiles under Joseph against all the soldiers under General Howard. The Indians, naturally a brave tribe, now flushed by success, and rendered desperate by their lot, seemed not unwilling to try the issue. Leaving their picturesque camp and cone-like teepees protected by the broad mountain-streams, they crossed over to meet us, and, swarming out of the river bottom, occupied the rocks and fir-crowned heights of the ravines, leaving the troops only the alternative to deploy as skirmishers, and throw themselves flat on the sunburnt grass of the open. Joseph promptly took the initiative, and tried the favourite and hitherto successful tactics of working round our flanks and getting in the rear; but in this he was checked each time. Our line finally developed into a crescent, with the baggage and hospital at the rear and centre. Nothing could be bolder or more aggressive than the conduct of these Indians. Twice they massed under shelter, and, leaving their war-horses in the timber, charged our line so savagely that they were only repelled by as fierce a counter-charge, the two lines advancing so rapidly that they almost met; and when the Indians turned, they did so only to regain cover. Their fire was deadly, the proportion of wounded to killed being but two to one. A large number of the casualties occurred in the short time before each man had protected himself with earth thrown up with his trowel bayonet. . . . All day long, under the hot July sun, without water and without food, our men crawled about in the parched grass, shooting and being shot. The wounded were carried back to an awning, where the surgeons were at work; the dead were

left where they fell. All day long the Indians fought hard for the mastery. Among the rocks and scrubby pines their brown naked bodies were seen flying from shelter to shelter. Their yells were incessant as they cheered each other on, or signalled a successful shot."

When night fell, a sort of pancake, cooked by the non-combatants, was distributed to each man of the command, but the enemy had taken possession of the only spring. "With the dawn the stray popping of rifles grew more and more rapid, till, as the sun shot up into the sky, both sides were hard at work again. . . . The Indians being more determined, if possible, than on the day before, and our side having received reinforcements, General Howard, at two o'clock, ordered a charge upon their position. Colonel Miller led the attack, which was desperately resisted. Some of the Indians made no effort to retreat, and were killed in their rifle-pits (Anglicé, shelter-trenches). But this ended the fight. They fled across the river, hastily gathered the women and children who had not been sent off, and throwing on pack animals such effects as they could secure in their haste, they were soon seen speckling the distant hills."

And now began a chase which was continued for three months, and a retreat which brings out in bold colours the tenacity of the redskin and the difficulties of Indian warfare. With a caravan of more than 2,000 horses, and accompanied "by women, children, old men, and old women, the wounded, palsied, and blind, Joseph followed a seemingly impossible trail, interlaced with fallen trees, through the ruggedest mountains. Twice he crossed the Rockies, the Yellowstone, and Missouri rivers, and when he was taken, within one day's march of the Canadian border, he had passed over nearly 2,000 miles of the ruggedest wilderness of the continent."

Besides the column under Howard, he was pursued by two others under Generals Gibbon and Sturgis. By the first of these he was surprised on the 10th of August, but after holding the enemy (less than one-third his strength) at bay for two days, he escaped under the cover of the night. Two days afterwards he made a night attack on the camp of Howard's and Gibbon's combined forces, and, successful in stampeding the pack animals, gained a long start of three days. After a march of 1,000 miles, he was overtaken by Sturgis, "reinforced by Howard's freshest cavalry, and again he started the caravan of women, children, and old men, whilst he and his warriors held their position and protected the retreat. Thus he made a running fight of two days, extending over 150 miles. Once more he distanced all pursuit, and was never again overtaken until he had crossed the Missouri. . . . During this march every vicissitude of climate had been felt: the cold, drenching rains of spring, and the heat of summer, the autumn extremes of temperature, when the midday in the mountains was very hot, and at night water froze an inch thick in the buckets. The men who pursued Joseph were mostly foot troops. They were necessarily reduced to the most meagre supplies."

In the middle of September, a new column, under General Miles, took up the chase. Joseph, who did not know of this enemy, and "was watching only Sturgis and Howard, was encamped along Eagle Creek. The country was bare, rolling grass prairie, and at this time covered with a light fall of snow. The camp lay in sheltering hollows—the lowest, and, therefore, for fighting purposes the worst situation. A blinding snowstorm shielded General Miles' approach on the morning of September 30, till he was almost upon them. Instantly, on discovering the advance, the Indians seized the crest of the knolls immediately surrounding the camp, and the cavalry charge was successfully repulsed. Every Officer and non-commissioned officer who wore a badge of rank was killed or wounded, save one. . . . The troops held most of the higher crests surrounding the camp. The

Indians, with wonderful labour and ingenuity, literally honeycombed a portion of the site of their camp with subterranean dwelling-places, communicating galleries, &c. Their dead horses were utilized as fortifications and food." Here they held out for five days, and had not the horses been lost, "it is more than probable that Joseph would have made another of his successful fights in retreat." On the evening of the fifth they surrendered, the Chief expressing himself in these words at the last council: "I am tired of fighting. Our chiefs are killed. The old men are all dead. It is cold, and we have no blankets. The little children are freezing to death. My people—some of them—have run away to the hills, and have no blankets, no food. No one knows where they are—perhaps freezing to death. I want to have time to look for my children, and to see how many of them I can find; maybe I shall find them among the dead. Hear me, my chiefs; my heart is sick and sad. From where the sun now stands, I will fight no more for ever!"

But the Nez-Percé expedition was, after all, but insignificant compared to the long war with the Sioux and the Cheyennes. "In 1875–76 a great army —for Indians—started to make war on other and peaceable tribes in Dakota, Montana, and Wyoming. The Sioux force numbered about 3,000 warriors, all mounted and armed with as good rifles and revolvers as those used by the regular army. An army, about equally large, and in three columns, started under Generals Crook, Gibbon, and Terry, towards a common point, to which it was supposed the main body of the Indians would make. The starting points were nearly 300 miles distant from each other, and the country was wild and utterly without roads; but the plan was the only one practicable, and the troops did wonders in the way of marching and fighting. Each column met some outlying bodies of savages, but Custer, with a detachment of Terry's column, numbering about 320 horsemen, struck the main body, fully 2,500 Sioux, and neither man nor officer escaped. The hostiles were given but little peace from that time forward. All the troops that could be spared were sent into the Sioux country. Crook chased, punished, and starved the greater body of the Sioux until they surrendered, and a force almost equally large, closely pressed by General Miles, took refuge in Canada."

Such is a brief outline of the series of campaigns which were not finally concluded until 1879. The principal actions were those of Little Big Horn, the scene of Custer's disaster; Cedar Creek, where Sitting Bull was defeated; Mackenzie's surprise of the Cheyennes; the engagement at Slim Buttes, where the American loss was 30; that of Rosebud, where 8 soldiers were killed and 26 wounded; and that of Wolf Mountain. Of minor collisions, there were many, and of one of these we shall quote the account given by Captain Charles King, late of the U.S. Army, well known as the soldier novelist, whose graphic and realistic pages are by far the best and truest pictures of military life that any pen has drawn, and whose work entitled "Campaigning with Crook" may be recommended to those who enjoy a stirring narrative, written in a most striking style, and at the same time containing a detailed and instructive description of the frontier service of the American cavalry.

Of all the Generals who were engaged in this troubled time, General Crook appears to have been the most able. That he has been named the "Apostle of the pack-train," indicates that his attention to convoy and commissariat was not the least amongst the causes of his success; and in adding friendly Indians to his forces to provide scouts and guides, he adopted a system, of which the 270 redskins who, under American Officers, now form part of the regular army, prove the efficiency. To fight the Indians with their own tactics was the rule which guided his conduct; and the ultimate surrender of

the Sioux and the Cheyennes was due to the manner in which he and other officers improved on the methods of their enemy.

The xpedition referred to was carried out by General—then Colonel—Wesley Merritt. A body of 800 Cheyennes was reported to this Officer, then in command of the 5th Cavalry, to be on the point of leaving their reservation to join the hostile Sioux. Throwing the Indians off their guard by starting in a direction exactly opposite to that which he proposed following, by a long and circuitous march, he gained, unobserved, a point on the War Bonnet river where the trail the Cheyennes were likely to use crossed the stream.

Here, concealed in the cotton woods which fringe the bank, he awaited the arrival of the war-party. At dawn on the next day his wagon train, escorted by two companies of infantry, was observed far away across the prairie slowly approaching the rendezvous, and at the same time the Indians appeared in large numbers, watching the slow progress of the convoy, but hidden from it by the undulations of the prairie.

Colonel Merritt ordered his men to saddle, but still held them concealed in the timber, and went himself to the little picquet which, posted behind the crest of a grassy ridge, kept a sharp look-out on the movements of the unsuspecting savages.

The rest is best told in Captain King's own words. "A mile and a half away, a party of thirty or forty Indians are scurrying about in eager and excited motion. Even while we speculate as to their purpose, it suddenly becomes plain. Riding towards us, far ahead of the wagon train, two soldiers come riding along the trail. They bring dispatches to the command, no doubt, and knowing us to be down here in the bottom somewhere, have started to reach us. They see no Indians; for it is only from them and the train that the wily foe is concealed, and all unsuspicious of their danger they come jauntily ahead. And now is the red man's opportunity. Only a mile away come our couriers. Only a mile and a half up the ravine a murderous party of Cheyennes lash their excited ponies into full gallop, and down they come towards us. In a moment the Colonel has ordered every man down off the hill and into the saddle—every man with one exception—an Officer is left at the crest to watch the advance, and give the word when the party should make its dash.

"Oh, what a stirring picture those Indians make, as once more we fix our gaze upon them. Savage warfare was never more beautiful than in these. On they come, their swift, agile ponies springing down the winding ravine; the rising sun gleaming on trailing war-bonnet and silver armlet, necklace, gorget; on brilliant, painted shield and beaded leggings; on naked body and beardless face stained most vivid vermilion. On they come, lance and rifle, pennon and feather, glistening in the morning light; the riders swaying in the wild grace of their peerless horsemanship. Nearer, till we can mark the very ornament upon their leader's shield. And so, on, too, came their helpless prey. We hold vengeance in our hands, but not yet to let it go. Five seconds too soon, and they can wheel about and escape us; one second too late, and our blue-coated couriers are dead men.

"On they come, savage, hungry-eyed, merciless. Two miles behind them are scores of their friends, eagerly and applaudingly watching their exploit; but, five hundred yards ahead of them, coolly awaiting their coming, are their unseen foes, beating them at their very game. Nearer and nearer; their leader, a gorgeous looking fellow on a bounding grey, signals to close and follow. Three hundred yards more, and their gleaming knives will tear the scalps of our couriers. Twenty seconds, and they will dash around that point with the warwhoop ringing in their ears. Two hundred yards—we can hear the panting of their wiry steeds. One hundred and fifty—ten

seconds more and they are on them. Then, crash go the hoofs! There is a rush and scurry and scramble, a wild ringing cheer, and the little squad leaps from its cover and charges home upon the Indian flank. There is a chorus of shots and shouts, and warning cries. Their leader, cool as a cucumber, wheels round and sends his bullet whistling past the Colonel's head. Buffalo Bill, our old-time scout, has tumbled a warrior from his pony, and both Indian and steed are stretched upon the turf, quivering in the death agony. Away whirl the foremost Cheyennes, dodging bullet or blade. 'Look! look to the front!' is the cry. And there, covering the slope like a red cloud, down come their scores of comrades, full charge, to the rescue. Full charge for more than half a mile, and then veer and swerve and sweep to right and left; for the long blue line of 'K' troop shoots up over the ridge, and to their right rear the greys of 'B' are echeloned. The bays of 'I' troop come plunging into line out on the left flank, and in less time than it takes to tell it, the seven troops are sweeping up the long wave of prairie, whirling the Cheyennes before them. . . .

"All the livelong morning, all the summer afternoon, the victors press their way, steadily herding before them the renagades back to their reservation. Baffled and astounded; for once in a life-time, beaten at their own game; their prospect of joining Sitting Bull nipped in the bud, they mourn the loss of three of their best braves slain in sudden attack, and, worst of all, their provender and supplies lost in the hurried flight.

"Wearied enough, we reach the agency buildings at seven that evening; disappointed perhaps at having bagged no greater game; but our chief is satisfied, and the Fifth generally goes to sleep on the ground, well content with the affair by the War Bonnet river. For the first time, in that campaign at least, the Indian was beaten at his own tactics."

Another successful expedition worthy of notice was that conducted by General Mackenzie, with a part of Crook's column, which effected the defeat of the Cheyennes in November, 1876.

1,100 Officers and men, one-third of whom where Indian scouts, the whole of the cavalry belonging to the column, was pushed ahead to surprise the hostile camp. The temperature at the time was 30° below zero, and the march of 76 miles was made over a country deep in snow, and at times in the face of driving storms. The road was reconnoitred by the Indian scouts, riding 30 or 40 miles on either side of the track; and, thanks to their sagacity, the troops were enabled to take up a position during the night within a few hundred yards of the Indian camp, and this without being observed. At daybreak a portion of the force charged the camp, and were successful in cutting off a large number of the enemy's horses, and in capturing 200 wigwams. Of the Indians, surprised by the sudden rush of the horsemen, many were killed; but, taking to the rocky heights which stood behind the village, they retreated slowly, maintaining a long rear-guard action during which they covered the withdrawal of their women, children, and wounded, and slowly fell back to a strong position six miles in rear. The troops than retired, the destruction of the camp having been the object of the expedition, and the tribe surrendered shortly afterwards at Red Cloud Agency.

General Crook's whole force consisted of 11 companies of infantry, 4 of artillery, and 11 troops of cavalry, together with 400 auxiliaries, a total of 1,900. The pack train included 168 wagons, 7 ambulances, 219 drivers, &c., and 400 mules employed in the independent cavalry expeditions. One of the latter, composed of 150 picked men, surprised, stormed, and captured an important Sioux village, at Slim Buttes, in September, 1876. But here again the Indians rallied, and although Crook's entire force came up to the relief of his advanced guard six hours later, surrounded the entire brigade

during the afternoon, and kept the Americans busily occupied until the village was destroyed, and the force commenced its retreat. "Incredible as it may seem," says Captain King, "there were probably not more than 300 Indians engaged against our 36 companies on that afternoon; and while we had not a horse fit for duty and made the fight dismounted, yet for two mortal hours those 300 redskins kept us as busy as though a division were in our front; and now they say they lost only seven warriors. Watching their active movements from his central position, and noting how like a flash they would concentrate in front of a weak, and break from before a strong, point in our line, General Merritt, who ought to know a skirmisher, finally declared, "The world has not a light cavalry to match them."

The same author describes in a spirited paragraph the tactics of the Sioux and Cheyennes during this protracted war, and what is more to the point, indicates the way in which their tactics may be best met. "It is impossible to fancy a system of tactics more baffling . . . striking with all the force of a tornado, yet vanishing into thin air before a counter-hit. Setting aside all questions of the defensive positions he utilizes when he can, taking him square out on the open prairie, his science never deserts him. Suppose a battalion of our best cavalry attacking an equal force of redskins, covering, we will say, the retreat of their women, children, and village, and therefore compelled to impede our march by show of fight. We either have or have not a pack-train to be protected, but we speedily will have wounded, to whom it will be death if left unguarded. We can *never* be utterly untrammelled; but 'Charge!' is the order, and then our long line sweeps at them over the rolling prairies, receiving their fire, but unable to reply. They break away before our front like autumn leaves before the gale, opening out right and left, every man for himself. We dash through what *was* their line only to see a dozen or so scurrying over the ridge in our front, while from flanks and rear a hundred and more are pouring in a rapid and telling fire. Wheel about and charge again, and the same thing happens; charge right and left, and, sure as shooting, one of your commands will be surrounded by greater force, and by a fire it cannot begin to answer. Your men are dropping from their saddles; you cannot reach the Indians, yet they hang about your flanks like myriad coyotes upon a wounded buffalo; they can scatter over the prairie in knots of two and three, and reassemble anywhere; you cannot disperse in pursuit without inevitable disaster.

"Dismount to fight on foot, and in a moment you are the centre of circumference of whooping Indians; they dash about at speed, 600 yards away, or, flat upon their faces along the nearest ridge, keep up their rapid fire. You can 'stand him off' indefinitely, but his shots, converging on your centre, must hit something; yours, radiating to his wide circumference, are as sure to miss.

"Man to man, steel to steel, he will not meet you; he knows just how to handle you and holds to it; he 'plays' you as a dexterous angler plays a game fish, gradually wearing you out.

"We never get a thorough advantage over the Indian except under the cover of surprise, and then it is slight enough, unless every care has been taken to surround him, and even then he fights with the desperation of death if he concludes to fight at all.

"The majority of cases in which the Indian is surprised and attacked in his village do not give a substantial result. Surprised ordinarily at dawn of day by a dash of excited troopers, who tear through his streets firing right and left, he simply slashes his way out of the back of his teepee, and, with his ever-ready rifle and ammunition, darts up the bluffs invariably found covering his townships, and in nine cases out of ten the cavalry commander finds that he has won what is of no possible use to him, and what he must lose half

his men in holding or destroying ; he has got the village, sure enough, but only to find himself surrounded and besieged."

The disaster on the Little Big Horn, the Isandhlwana of the American army, was an attempt made by General Custer with 300 of the 7th Cavalry to defeat 2,500 Sioux in open daylight. Both men and horses were jaded with a long march. The force was divided into two small columns to attack, five miles distant from each other. The Indians occupied a strong central position, thus making easy the overthrow of either party before the other could be brought to its support.

Railways and telegraphs have enabled the United States authorities during the later campaigns in the North-West to effect the rapid concentration of large bodies of troops in the disturbed districts, and expeditions need no longer be confined to a few troops of cavalry. This, in itself, is an important change in the procedure of Indian warfare. Moreover, the employment of Indians to fight Indians, just as we ourselves match Pathan against Pathan on the North-West Frontier of India, has greatly extended the means of obtaining information, and, at the same time, the chances of surprising the villages.

Rapidity of pursuit has also been recognized as essential to success, and at the beginning of the late outbreak, General Miles is reported to have ordered two regiments of foot to be at once transformed into mounted infantry. Rifle-shooting has also been a marked object of attention on the part of the War Department, and the American soldiers are, generally speaking, good marksmen.

The cavalry, or, to name them correctly, the dragoons, have the lion's share of work in Indian campaigns. They are armed with the sabre and the Springfield carbine. The McClellan saddle, which stood so well the arduous four years of the Secession War, appears to have few, if any, detractors, and sore backs are rare. Many suggestions have been made from time to time with a view, by decreasing the weight carried by the horse, to put the trooper on a level with his more lightly equipped and therefore more mobile adversary, but the objections to depriving him of any portion of his kit seem unsurmountable. It may also be noticed that there are complaints amongst the Officers as to the horsemanship of the men. The numerous forts in which the troops are cantoned along the extensive frontier are not provided with riding-schools. The instruction of the recruit is, therefore, a difficult business, and when winter confines the garrison within its stockades, both men and horses get rusty. The drill of the cavalry is based on formations in single rank. When the force dismounts, one man holds four horses, linked together by their bridles. The line is broken up into skirmishers, supports, and reserves ; and the horses are protected by the reserves, or placed under special guard. The artillery which accompanies the columns are Gatling machine-guns and the 3·2 inch Hotchkiss quick-firing rifle. The gunners are also trained to act as infantry. Entrenching tools are always carried by the troops ; and against such marksmen as the Indians, close-order is never employed ; the line of defence is composed of skirmishers sheltered in rapidly-constructed rifle-pits and trenches.

The tactics practised in the North-West do not indeed throw much light on the vexed question of the proper formation in which to meet savages of the type of the Zulu or the Soudanese, line, square, or échelon. But they afford useful suggestions for the employment of mounted infantry, and throw some light on the methods in which an enemy superior in marksmanship and in mobility may be dealt with. Regarding this last point, it must be remembered that the American cavalryman is a dragoon, that is, he is taught to charge with the sabre as well as to fight on foot, and also, that he is armed only with a carbine.

III.

The engagements, if they may so be called, of the 1889–90 operations in South Dakota do not present many points of interest. We may well conceive that the Indians were awed by the quick and resolute preparations made by General Miles. On the first alarm, or as soon as it was apparent that the Ghost Dancers were working themselves up to a pitch of frenzy troops were brought into the State from far distant garrisons; and, although the situation was for a time precarious, and ranches were burnt, settlers murdered, and stock captured on every side, it was not long before a sufficient force was gathered together to prevent more extended raids, and to bring about the surrender of many of the hostile chiefs. A number of disaffected Sioux, irritated at the reduction of their supply of rations, and excited by the promises of a crazy fanatic, took refuge in the Bad Lands, some 40 or 50 miles north of the Pine Ridge Agency. Others endeavoured to join them, and the whole territory between the Big Cheyenne and Niobara rivers was disturbed by war-parties and raiders. The first important incident was the capture and death of Sitting Bull, who was believed to be on the point of joining the malcontents with his 100 or 200 braves.

"A party of Indian police," according to a Dalziel telegram, "marched out from Standing Rock Agency on the morning of December 16th, with the object of arresting the famous Sioux chief.

"When they reached Sitting Bull's camp they found the Indians ready to march, their ponies painted, and many of the savages stripped for war. The police made a dash into the camp. They seized Sitting Bull, and were returning to Standing Rock Agency when Blackbird, the tall, athletic son of the famous chieftain, urged his comrades to recapture the old man. The women and children were hidden away in the bushes, and then with yells the Indians charged the police, firing incessantly as they came up. A hand-to-hand struggle ensued, during which Sitting Bull, who was not shackled, could be heard giving his orders in a loud voice.

"For several minutes the firing was heavy, and so well directed that nearly every man who was hit was killed. When the fusillade was hottest, Sitting Bull fell out of his saddle pierced by a bullet, but whether the shot was fired by the charging Indians or by the police is not known. The son of Sitting Bull was slain almost at the first volley fired by the police.

"The Indians fired with deadly accuracy, and slowly drove the police from the field.

"Before the firing ceased, three troops of cavalry arrived upon the scene where the police had been routed by the skilful sharpshooting of the rebels. The troops had brought two machine-guns with them, and these being rapidly let loose upon the Indians, within a few minutes the latter were beyond range, and were tearing at a furious rate on their ponies in the direction of Bad Lands.

"Had not the cavalry arrived in time, it is probable that the police would have been annihilated. The soldiers were quick to enter into action; a skirmish line was thrown out, and then, kneeling and firing as they advanced, the troops, with the machine-guns playing over their heads, poured a withering fire into the ranks of the savages."

The hostile camp in the Bad Lands is reported after this to have swelled in numbers to about 4,000 souls, of whom nearly one-third were presumed to be braves; but by Christmas the force of troops had increased to at least 3,000. Sitting Bull's band, under the chief Big Foot, was overtaken by the 7th Cavalry, and surrendered peacefully. But, when they were ordered to disarm, some days later, a sudden frenzy appears to have seized them. The correspondent of the "Daily Telegraph" thus describes the scene that followed:—

"At dawn on Monday the United States troopers were drawn up in line of battle 100 yards away from the Indian camp, K troop, under the command of Captain Wallace, being in the van. The warriors tumbled out of their tepees and squatted on the ground in a half-circle, while a battery of Hotchkiss guns was placed in position on the crest of a commanding butte about 100 yards behind the soldiers. It was noticed that the Indians were sullen, and seemed to be in a bad humour. Big Foot, who was so ill that he could not stand erect, crawled from his tepee and extended his hand as a sign that he wanted peace. The squaws were huddled behind the semicircle of braves, while all around the camp the Indian children played and romped unconscious of the approaching storm.

"When everything was in readiness Major Whiteside, speaking through an interpreter, in answer to Big Foot's request for peace, formally demanded of the chief the unconditional surrender of his braves. The Indians were, as usual, provokingly slow to act; but, finally, twenty of them arose, and, with aggravating deliberation, approached the troopers, who were dismounted. Two of them dropped a couple of inferior looking rifles upon the ground. Major Whiteside lost his temper at this display of rebellion, as it was known that the Indians were well armed, and he ordered some of the soldiers of Troop K to search the tepees. The troopers obeyed, and, led by Captain Wallace, marched forward and began the search at once. In the meantime another troop surrounded the Indians, who began to slowly rise from their squatting position on the ground.

"Suddenly, like a flash of lightning, and without the slightest warning, the warriors flung their blankets aside, and in the hands of each was seen clasped a rifle, which until that moment had been concealed. Before a word could be said or an order given to the imperilled troopers in the tents and surrounding the camp, a terrific volley was fired into their ranks by the savages. So close were some of the soldiers that the muzzles of the Indians' guns were pressed against their bodies. There was a sharp clicking of shell ejectors, and again a sheet of flame shot from the rifles of the hostiles. The soldiers dropped like leaves from the trees, and for a moment Troops K and A wavered before the terrible onslaught. Some of the soldiers were in the tents, while others filled the space between the actual combatants and the rest of the soldiers, who were hastily preparing to go to the relief of their comrades.

"The troops fell back in disorder, and the handful of redskins fought with fiendish audacity. For a brief space of time, 160 Indians threw into confusion 1,600 of the best fighters of the United States Army, equipped with the most improved machine-guns, and commanded by veteran Officers. The dismay of the troopers was, however, momentary; but the Indians would not be denied. It seemed to be their deliberate purpose to perish fighting, and there was no running on either side. After two or three terrible volleys, the Indians, shrieking their awful warcry, pressed forward against the remnants of the two shattered troops. Not a single commissioned or non-commissioned officer of K Troop had survived. Captain Wallace fell dead in the folds of a tepee, with a rifle-bullet in his brain, while his face was tomahawked, and his skull smashed in with a stone war-club. Scattered around him were his men, dead and dying.

"But the recoil came as suddenly as the treacherous onslaught of the Indians. The first volley of the whites was fired by the scouts commanded by Captain Taylor. The Captain had ordered his men to throw themselves upon the ground to prevent their being mistaken for hostiles, as they were attired in the typical dress of the Indian scouts. Thus, lying on the ground, Taylor's force poured a deadly fire into the hostiles. The scouts, Indians to a man, remained loyal and brave, and did terrible execution.

"Five minutes after the first shot was fired the whole regiment was in action, and the troopers charged upon the savages in the sunken ground where Big Foot's village had been pitched. Then ensued a terrific onslaught. The Indians fought like demons, while the soldiers poured volley after volley into the camp, regardless of the sex and age of its occupants. Through the smoke which hung over the tepees the warriors could not be distinguished from the old men, women, or children, and the slaughter fell upon them as upon the fighting men. The 7th Cavalry then plunged into the camp and upon the screaming savages, who fought with rifles, pistols, tomahawks, bludgeons, and knives.

"The ground was strewn thick with dead and wounded, and fleeing in all directions were the squaws, stumbling under loads of children in their blankets, making for the buttes and gullies. The soldiers' bullets brought scores of them to the earth, as well as warriors. While the latter were lying upon the ground, wounded or dying, they continued to shoot at the soldiers, and many of them, after the cavalry had passed over them, were seen to rise partially from the ground, throw up their rifles, and shoot the troopers in the back.

"The tumult raging round the camp culminated in a fire. The flames enveloped the tepees, while hundreds of Indian ponies stampeded and rushed wildly in every direction. During the fiercest of the fight Lieutenant Garlington, who had been conspicuous in the battle, fell from his horse wounded. A party of Indians made for his body, but the instant the Lieutenant fell the Grey Horse squadron, which he commanded, dashed upon the Sioux and killed every one of them without exception.

"The strength of the 7th Cavalry soon told its story, and within half an hour two-thirds of the hostile Indians lay dead. The corpse of Big Foot was found, his grim, merciless face besmeared with blood, and his hand clutching the dirty blanket which partly covered the bullet wounds in his breast. During the hand-to-hand conflict he was recognized by the soldiers, and slaughtered like a wild beast. Dead at the chief's feet lay his squaw, shot through the heart.

"A small remnant of the band fled through the ravines towards the low hills, but few even of these escaped, for by this time the battery of machine-guns on the big butte to the south began its deadly work. The crest of the butte was enveloped in smoke, through the centre of which flashed two streams of fire, moving east and west. The bullets showered upon the hills like raindrops, and the artillery, which had been under fire from the first, but was unable to reply for fear of hitting the troopers, now made a clean sweep of the country. Through the ravines and into the red willow bushes the guns poured a leaden torrent, until the hill-sides were dotted with the dead warriors, squaws, and children. The savages who were not hit by the cannoneers were pursued by a body of troopers under Colonel Forsythe and Lieutenants O'Hara, Robinson, and Rice.

"Captain Wallace, 25 soldiers, and 1 Indian were killed, while 38 soldiers were wounded, many of them seriously.

"Sixty-two Indian dead were counted on the plain, where the fight began, and in other parts of the ground were 18 more. These do not include the killed in the ravines, where dead Indians were seen, but not counted. Six Indians were brought in fatally wounded, and 6 more, who were with a party of 23 men and women, whom Captain Jackson had to abandon when attacked by about 150 Brule Indians from the Agency, were also killed. This accounts for 92 men killed, and leaves but few alive and unhurt. The women and children fled to the hills when the fight commenced, and comparatively few of them were hurt, and few were brought in. Thirty-nine of them are here, of which number 21 are wounded."

The number of women and children killed is not accurately known. That a good many fell under the devastating fire of the machine-guns and the rifles is certain, and, under the circumstances, was unavoidable. The treachery of the warriors brought down punishment on their unfortunate families.

The third remarkable incident of the campaign occurred on the following day, December 30th, and is thus reported by Dalziel :—

"General Brooke has just received news from the scene of yesterday's fighting at Clay Creek, when six men of the 7th Cavalry Regiment were killed and many wounded. The first intimation of trouble at the mission was brought late yesterday afternoon, when a courier rushed in with the startling news that the mission building—in which were a number of Catholic priests and sisters, with hundreds of children—was surrounded by hostile Indians, and had been set on fire. The cavalrymen, who had scarcely left the saddle for four days, were instantly mounted again, and, with a couple of Hotchkiss guns, started full gallop for the mission. They found the day school, 1 mile on this side of the mission, on fire. The Indians, under the command of Little Wound and Two Strikes, they found, to the number of 1,800, about a mile beyond the mission. The 7th Cavalry Regiment quickly formed in line and began the fighting, which was carried on by only 300 or 400 Indians at a time, while the balance of them were kept carefully concealed. Colonel Forsythe, suspecting an ambush, did not let them draw him into dangerous grounds.

"The troops had passed the Catholic Mission House, and had dismounted in a big valley 1½ miles wide. Just beyond the school at the end of the valley there is a narrow canyon, 75 feet wide and 300 yards long, opening into a small park. The object of the Indians was to drive them into this gorge. The soldiers were preparing to rush on foot to the top of the hill when the cry arose that they were surrounded. Whichever way they went they met bodies of 200 or 300 Indians, and with lightning rapidity the hills swarmed with redskins, estimated to number from 1,800 to 2,000. Twenty minutes later the fate of the 7th Regiment of Cavalry appeared to be sealed, when suddenly a detachment of the 9th Regiment arrived on the scene.

"Colonel Henry started for the scene about an hour later than Colonel Forsythe. Owing to the extreme exhaustion of the horses and men the marching was slow. When he arrived he found the 7th Regiment completely surrounded by the redskins, and just as the circle was ready to charge he attacked them. After a short skirmish the Indians retreated and vanished. The weary soldiers then slowly retired, reaching the agency at dark."

The greater part of the 9th Cavalry had marched 80 miles during the day and night previous to this engagement.

NOTICES OF BOOKS.

The Armies of Europe. Illustrated, translated, and revised by Count GLEICHEN, Grenadier Guards, from the German of Fedor von Köppen. Illustrated by Richard Knötel. London: Clowes, 1890. Pp. 81. Size 10¼″ × 7½″ × 1″. Weight under 2 lbs. Price 12*s.*

Taking into account the matter contained in this volume, and the number and excellence of the coloured illustrations, this is an extraordinarily cheap publication. It gives in a handy form the pith of the information contained in those erudite but somewhat dreary books, "Armed Strengths." It would be a useful addition to any library.

The Indian Mutiny of 1857. By Colonel G. B. MALLESON, C.S.I. London: Seeley, 1891. Pp. 421. Size 8″ × 5½″ × 1¼″. Weight under 1 lb. 10 oz. Price 5*s.*

The author is so well known and so great an authority on any matters connected with Indian history that a small condensed account of the Mutiny of 1857 from his pen is most welcome. Since he completed "Kaye's History of the Mutiny" he has visited India again, and he returned confirmed in the conviction he held before the Mutiny broke out, that the discontent and anger which found vent in the Mutiny arose not from the greased cartridge incident, but from indignation excited by our policy towards Oudh, and the dislike to the action of the land system introduced into the N.W. Province.

The greased cartridge was a grievance which touched the strong religious susceptibilities of the Sepáhis, and was the spark which set fire to the train of gunpowder.

Dressage Méthodique du Cheval de Selle par un des Élèves de F. Baucher. Paris: Rothschild, 1891. Pp. 204. Size 9″ × 6″ × ¾″. Weight under 1 lb. 6 oz. Price 6*s.* 6*d.*

This is a treatise of a very detailed and technical nature. The author very rightly points out the great difficulty in explaining in writing or verbally some details which are more of a practical than a theoretical character; and the difficulty is increased by the fact that some expressions adopted by Baucher are, perhaps, open to discussion from a strictly scientific or grammatical point of view. These expressions have, nevertheless, very properly been retained, and the author reminds the reader that, "souvent la plus petite démonstration *à cheval* rendrait clair à l'instant ce qui paraît obscur *par écrit*, malgré de longues et minutieuses explications."

Broadsword and Singlestick. By R. G. ALLANSON-WINN and C. PHILLIPPS-WOOLLEY. London: George Bell, 1890. Pp. 116. Size 6¾″ × 4¾″ × ½″. Weight under 8 oz. Price 1*s.*

This is one of the "All England Series"; it is at once interesting and amusing, and withal of practical value. The book contains instructions which may come in useful at any time on the use of the Cudgel, the Shillalah, the Walking Stick, and the Umbrella!

The Life of Ferdinand Magellan, and the First Circumnavigation of the Globe, 1480–1521. By F. H. H. GUILLEMARD. London: Philip and Son, 1890. Pp. 353. Size 7¾″ × 5½″ × 1½″. Weight under 1¾ lbs. Price 4*s.* 6*d.*

This book, one of the series "The World's Great Explorers and Explorations,"

gives the first account in English of the life of Magellan, and a perusal of it will prove the accuracy of the statement made by the author in his preface, that the world is year by year presented with biographies of persons who cannot lay claim to a tithe of the renown so justly accorded to this explorer. The book is one of exceptional interest; it puts before us an episode of exploration of importance as lasting as that of the duration of the globe; reveals to us matters of which hitherto we have been in complete ignorance, and tells a tale of hardships endured and, it is sad also to say, bloody conflicts with the real proprietors of the countries discovered, and, still more sad, of the lowering of that standard of moral right to which many explorers subject themselves when in pursuit of their one idea, opening up fresh regions of the world. Not even to "In Darkest Africa" is the account of the discovery of the Straits, the passage through them, the death of the leader, and the completion of the circumnavigation, in Mr. Guillemard's work, inferior in interest and dramatic incident. The book is accompanied by admirable maps, and would be very widely read if only some sensational title had been given to it.

Grusonwerk—Magdeburg—Buckau. Messrs. G. C. Warden and Co., of 75, Queen Victoria Street, have sent us three books published by Whitehead, Morris, and Co., descriptive of some of the military appliances produced at the Grusonwerk. 229 pages of text and a number of highly-finished drawings are comprised in the three covers. Size 10″ × 7″ × 1¼″. Weight under 2 lbs. 10 oz. Captain A. H. WHITE (retired), Royal Marines, is the translator.

The first book deals with chilled cast-iron armour and minimum-port carriages. Although we in this country have not gone in for any very extensive use of iron in our fortifications, yet we may have to attack coast fortresses defended by iron constructions, and, therefore, it is interesting to know what is being done by other nations in this matter. The book gives an account of the manufacture, history, and development of the chilled cast-iron armour work, and of the later constructions for which it is used.

In another section of the work is given a collection of drawings and descriptions of the shielded mountings and shielded emplacements lately set up on the trial ranges of the Grusonwerk, forming a continuation and completion of the second edition of the pamphlet printed for private circulation in the year 1889: "The Shielded Mountings on the Trial Ranges of the Grusonwerk in Buckau and Tangerhutte."

The third section is that which is of most general interest, and is also a continuation of a pamphlet of similar title distributed in 1888: "The Gruson Quickfiring Guns, their Mountings, Ammunition, and Ballistic Relations." The guns described are 14 in number, and extend from that of 1·46 inches in calibre to that of 3·23 inches; a description of two other pieces of ordnance, one a 4·72-inch quickfiring howitzer, is also given; the rate of firing is from 45 to 20 rounds per minute. Some range tables are added, the introduction of smokeless powder rendering them, however, provisional. One or two instances will suffice. At 8,000 yards the 3·15 gun, with an elevation of about 26 degrees, puts 50 per cent. projectiles into a target 31·5 feet broad and 177 feet long. At 2,000 yards the 2·09 inch, with an elevation of 2½ degrees, put them into a target 5·6 feet high, 3 feet broad, 85 feet long.

The books are not for sale, but can be obtained on application to Messrs. Warden.

A Guide to Health: for the Use of Soldiers. By Surgeon-Major R. C. EATON. London: Cassell. Pamph. pp. 96. Weight under 6 oz. Price 2*s*.

All knowledge may be more or less useful, and therefore even to a man whose clothing, housing, and food are provided for him, and who does not decide these matters for himself, perhaps a knowledge of what would be best for him may sometime be turned to account. The Surgeon-Major does not, however, tell the soldier anything about that which would, perhaps, be of some influence with him, the terrible dangers which ruin the health of our Army and Navy under the protection of the repeal of the Anti-Contagious Diseases Act. Had this subject been boldly

dealt with, many Officers would then have procured the circulation of the pamphlet among their men.

The Bucaneers and Marooners of America. Edited by HOWARD PYLE. London: Unwin, 1891. Pp. 403. Size 8¼″ × 6″ × 1¾″. Weight under 2 lbs. Price 5*s*.

This book is a new illustrated edition of one of the "Adventure Series," and contains much details of repulsive cruelty and barbarity. The editor asks, "Would not every boy, for instance—that is every boy of any account—rather be a pirate Captain than a Member of Parliament?" His ideal Captain is "one who swoops down on some merchant vessel with rattle of musketry, shouting, yells, and a hell of unbridled passions to rend and tear;" and this devil he calls a "Carlislean hero." Poor brave old John Shipp, what company the editor of the "Adventure Series" has put you in! It's enough to make you turn in your grave.

EXTRACT FROM THE BYE-LAWS.

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